No. 4171

United States
Circuit Court of Appeals
For the Ninth Circuit.

BOOK OF EXHIBITS.
(IN THREE VOLUMES)

OSKAR HUBER,

Appellant,

vs.

WARREN BROTHERS COMPANY, a Corporation,

Appellee.

VOLUME I.
(Pages 1 to 448, Inclusive.)

Upon Appeal from the United States District Court for the District of Oregon.

Filmer Bros. Co. Print, 330 Jackson St., S. F., Cal.

No. 4171

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INDEX TO EXHIBITS.

[Clerk's Note: When deemed likely to be of an important nature, errors or doubtful matters appearing in the original certified record are printed literally in italic; and, likewise, cancelled matter appearing in the original certified record is printed and cancelled herein accordingly. When possible, an omission from the text is indicated by printing in italic the two words between which the omission seems to occur.]

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Plaintiff's Exhibit No. 2.

KNOW ALL MEN BY THESE PRESENTS: THAT WHEREAS, I, FREDERICK J. WARREN of Newton in the County of Middlesex and Commonwealth of Massachusetts, whose post office address is Boston in the County of Suffolk and said Commonwealth, am the inventor of a certain improvement in pavements for which I have made application for Letters Patent of the United States, to wit, Serial No. 60,450, filed May 16, 1901, and

WHEREAS Warren Brothers Company, a corporation duly organized under the laws of the State of West Virginia and having a place of business in said Boston, is desirous of acquiring my interest in the same,

NOW THEREFORE, be it known that for and in consideration of one dollar and other good and valuable considerations to me paid by said Warren Brothers Company, the receipt whereof is hereby acknowledged, I, the said Frederick J. Warren, have sold, assigned, transferred, and set over, and by these presents do sell, assign, transfer, and set over unto the said Warren Brothers Company the full and exclusive right to the said invention and to the Letters Patent of the United States which may be granted therefor. And I do hereby authorize and request the Commissioner of Patents to issue the said Letters Patent upon the aforesaid application to the said Warren Brothers Company as the assignees of my entire right, title, and interest in and to the same for the sole use and behoof of

the said Warren Brothers Company and its legal representatives and assigns.

IN TESTIMONY WHEREOF, I have hereunto set my hand and seal this twenty-eighth day of May, 1902.

FREDERICK J. WARREN. (Seal)

Signed in presence of,

RALPH L. WARREN.

H. F. FOWLE.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, ss. BOSTON, May 28, 1902.

Then personally appeared the above-named Frederick J. Warren and acknowledged the foregoing instrument to be his free act and deed.

Before me,

(Seal) HENRY F. FOWLE,
Notary Public.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 3.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

2–390.

UNITED STATES OF AMERICA,
Department of the Interior,
United States Patent Office.

To all to whom these presents shall come, Greeting:

THIS IS TO CERTIFY that the annexed is a true copy from the Records of this Office of the File Wrapper and Contents in the matter of the Letters Patent of

Frederick John Warren,

Number 727,505, Granted May 5, 1903

for Improvement in Pavements.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this 1st day of October, in the year of our Lord one thousand nine hundred and thirteen and of the Independence of the United States of America the one hundred and thirty-eighth.

[Seal] R. T. FRAZER,
Acting Commissioner of Patents.

DIV. 15. 2–437.

NUMBER (SERIES OF 1900).

A

60450 1901. DIV. 15

(EX'R'S BOOK) 146

PATENT No. 727505 1697

Name—Frederick John Warren.

of Newton,

County of

State of Massachusetts.

Invention—Pavements.

Division of App., No. , filed

PARTS OF APPLICATION FILED.

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Patented	May 5,	, 1903
Associate Attorney	Attorney Clarke & Raymond 35 Court St.	
Address	Address. Boston, Mass.	
Patent No.	Date of Patent	

Case A.

One 5ct. and Two 10ct.
I. R. stamps affixed and canceled
"F. F. R. 2d 5-14-01"
AMOUNT RECEIVED
$15–Ck
CHIEF CLERK.
Registered
No. 1224.

APPLICATION FOR LETTERS PATENT.

To the Commissioner of Patents,
Washington, D. C.:

YOUR PETITIONER Frederick John Warren of Newton in the County of Middlesex, and Commonwealth of Massachusetts, whose Post office address is 143 Federal, S T., Boston, Mass. hereby prays that Letters Patent may be granted him for Improvement in Pavements set forth in the annexed Specification, and hereby appoints F. F. RAYMOND, 2d, doing business as Clarke & Raymond
35 Court St.
(Registered No. 1224) at ~~19 Pemberton Square~~ Boston, Mass., his Attorney, with full power of substitution and revocation, to prosecute this Application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

FREDERICK J. WARREN.

Case A

SPECIFICATION.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, Frederick John Warren of Newton in the County of Middlesex and Commonwealth of Massachusets, a citizen of the United States, have invented a new and useful Improvement in PAVEMENTS of which the following is a full, clear and exact description, reference being had to the accompanying drawings, forming a part of this specification in explaining its nature.

The invention relates to an improvement in the class of pavements which comprises a base of mineral matter and a plastic uniting medium consisting of a natural or artificial asphalt or coal tar composition which are intimately associated together and used as the main upper or top surfacing of the road-bed.

The invention is based upon my discovery that to ensure the best conditions of construction, wear and life in such pavements, the portion of the pavement to which my invention relates must be made as dense, as free from voids as possible and also stable and non-liable to displacement, and upon my further discovery that what has ordinarily been supposed to be the best provision for eliminating voids and establishing stability has, as a matter of fact, been almost the poorest provision for accomplishing these purposes. The provision usually accepted as the best is that in which the mineral matter used as a basis of the pavement and united by the plastic asphalt vehicle shall be in the

shape of a sand or fine gravel. This, however, is an error, as I have discovered by experiment that there is a smaller percentage of voids in a pavement which contains mineral components which are of relatively large size. The method has been in the construction of this class of pavements to exclude from its composition all pieces of stone or sand larger than 1/10 of an inch in diameter, but by so doing the smallest percentage of voids that it has been possible to produce has been 21% of the aggregate, while by the use of the larger sized grains or pieces, say up to those which will pass through a two-inch ring, and employing with these larger grains proper quantities of the smaller sizes, down to an impalpable powder, it is possible to reduce the voids of the mineral base below 10% of its bulk, and such a mixture when assembled and compacted together will form a dense, solid, homogeneous, compact body with the smallest percentage of voids and possessing the highest degree of stability and one in which the largest and smallest pieces are associated with each other indiscriminately throughout the structure and one which, because of the sizes of the pieces and their arrangement with respect to each other, offers the smallest areas of surfaces for the attachment of the plastic composition of them, so that not only is a superior binding effect or union obtained by the plastic composition, but a smaller quantity of it is necessary for the purpose of obtaining the superior result or product.

I prefer to use from 1 to 3% of impalpable powder, from 10 to 30% of material between impalpable powder and ¼-inch in size and from 50 to 80% of material larger than ¼-inch in size. I have found that these ingredients when associated together produce a mass or body having less than 20% of voids.

I prefer to use as the uniting or plastic composition one which comprises asphalt and an oil flux heated to a moderate heat to provide the requisite fluidity, but I do not confine myself to any special form of artificial or natural asphalt.

It will be understood that the mineral components are not arranged in the form of layers of the same size, but are mingled with each other from the upper to the lower surface of the pavement, and that the plastic composition permeates the entire mass, uniting the various sized particles thereof, filling the voids and forming the surfaces. It will be understood that this pavement is used as the upper or wearing section of a road-bed and that it may be covered if desired with a relatively thin surfacing of clear asphalt cement or an asphalt or bituminous composition of any desired nature. In some instances there may be rolled into this thin surfacing, while it is yet soft, sufficient sand, gravel or fine stone to prevent its displacement by traffic.

I will now describe the invention in connection with the drawings where

Figure 1 is a view in horizontal section of enough of a pavement to illustrate in a conventional way

the features of my invention, while Figs. 2 and 3 are corresponding views representing the addition of a surfacing to the structure of Fig. 1.

In the drawings:—

A represents the portion of the road-bed to which my invention relates and which may be called the wearing section of the road-bed and is the portion which covers and is supported by the McAdam or other foundation B. In the wearing section are

b. 12-02

represented some of the larger ~~metal~~ mineral Λ pieces, some pieces of intermediate size and some of the smaller pieces and also the plastic composition which unites them together and C represents the surfacing to which I have referred. It is represented as somewhat thicker in Fig. 3 than in Fig. 2. It will be understood, however, that the drawings are simply illustrative and that it is not possible to represent the variations in the sizes of the ~~metal~~ mineral Λ pieces, atoms and powder which are employed in producing my improved result.

In laying the wearing surface, the pieces, particles and atoms of the base are intimately associated with the plastic asphalt composition which is then spread uniformly upon the prepared foundation and which in setting becomes very dense, solid, stable and freer from voids than any pavement of which I have knowledge.

This density of the structure, stability, its relative freedom from voids very much improves the wearing properties of the pavement, its resistance

to the action of water and on account of its dense structure prevents the volatilization or oxidation of the essential oils in the cementing medium, increases its life and, while producing these improvements it also enables the wearing surface to be produced at a smaller cost because a smaller quantity of plastic asphalt material is required than where the percentage of voids is larger.

A pavement or wearing section of a pavement having the features of this invention possesses various advantages, among which are the following: First, the percentage of mineral employed is increased and the percentage of plastic uniting medium decreased as compared with analogous pavements as now laid. Second, the wearing properties of the pavement are increased and improved and this is due to the employment of a larger proportion of mineral to the proportion of the uniting medium and also to the fact that the mineral base is of such a structure, owing to the employment of a considerable percentage of relatively large pieces; larger than are now used; that a very rigid and stable effect is obtained and one which reduces strain and wear upon the uniting medium, more of the wear being borne by the mineral base and less by the uniting medium than is common. Third, the interstices of voids formed by such mineral components are also of a different character in that they are larger, fewer and therefore the asphalt or bituminous uniting medium contained in them forms a cellular structure which is stronger and adheres

better to the surfaces of the mineral components than where the voids or interstices are more numerous and of less size. I am also enabled because of the size of these interstices or voids to use an asphalt or bituminous uniting medium of a softer nature and at a lower temperature than could otherwise be used.

Sub. C March 26-03

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States:—

1. A wearing section of a pavement comprising a base of pieces of mineral varied as to size from a powder to pieces larger than one quarter of an inch in diameter and having the proportions to each other herein indicated to decrease the percentage of voids, with a plastic, bituminous composition combined with and united to said mineral base.

Sub. A Feb. 12-1902

2. A wearing section of a pavement having a mineral base of fine, intermediate and coarse pieces in about the proportions indicated herein, and mingled together to decrease the percentage of voids, a plastic, bituminous composition intimately associated with said mineral pieces uniting them together and filling the said voids, and a thin, finishing coating of relatively clear or non-mineralized, bituminous medium applied to the upper surface of the said wearing section and united to it.

3. A wearing section of a pavement consisting of fine, intermediate and coarse pieces of mineral of the sizes and proportions described and adapted when mingled together to provide a solid, stable base not liable to displacement by traffic and a low per-

centage of voids, and a plastic, bituminous binder or uniting medium combined with said base, filling the voids and uniting its individual parts.

4. A pavement comprising a suitable foundation, a wearing section mounted on said foundation comprising a mineral base of fine, intermediate and coarse pieces assembled together in the proportions indicated and for the purpose of ensuring stability combined with elimination of voids, and an asphalt, plastic combining medium intimately associated with said mineral pieces to fill the voids thereof, and a thin finishing body applied to the top of the wearing section comprising a relatively clear bituminous plastic medium and sand gravel or fine stone rolled into the same to prevent its displacement.

FREDERICK JOHN WARREN.

Witnesses
F. F. RAYMOND 2d.
J. M. DOLAN.

State of Massachusetts,
County of Suffolk.

Frederick John Warren, the above-named Petitioner, being duly sworn, deposes and says that he is a citizen of the U. S. and resident of Boston, Mass. and that he verily believes himself to be the original, first, and sole inventor of the improvement in Pavements described and claimed in the annexed specifications; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof; or patented or described in any printed publication in any country

before his invention or discovery thereof, or more than two years prior to this application; or in public use or on sale in the United States for more than two years prior to this application, and that no application for patent on said improvement has been filed by him or his representatives or assigns in any foreign country, except as follows:

FREDERICK JOHN WARREN.

Sworn to and subscribed before me this 9th day of May, 1901.

[Seal] F. F. RAYMOND 2d,
Notary Public.

Mail Room, May 16, 1901. U. S. Patent Office.
Serial No. 60450, Paper No.
Application.
Filed May 16, 1901.
F. J. Warren.

2—260.

Div. Room No. 207
Address only
"The Commissioner of Patents,
Washington, D. C."

Paper No. ———
All communications respecting this application should give the serial number, date of filing, and title of invention.

M. A. M.

DEPARTMENT OF THE INTERIOR
UNITED STATES PATENT OFFICE.
WASHINGON, D. C.,
June 20, 1901.
MAILED " " "
DIVISION 15.

Frederick J. Warren,
Care of Clarke & Raymond,
No. 35 Court Street, Boston, Mass.
(Case A.)

Please find below a communication from the

your

EXAMINER in charge of ~~the~~ application ~~of~~ Serial No. 60,450, filed May 16, 1901, for Pavements.

F. I. ALLEN.

~~E. B. MOORE.~~

Commissioner of Patents.

This application has been examined.

Although perhaps the term "metal" is sometimes used in the trade, yet it is suggested that mineral be substituted in lines 7 and 14, page 4.

Claim 3, after "and" line 5, insert having.

The alternative form of claim 4 is objected to and would be remedied by cancelling "gravel or fine stone."

So far as set out in the claims, applicant's pavement shows no patentable novelty. Many references might be cited to show the use of a mixture of stones of various sizes with bituminous compositions. It will be enough to cite for this the patent to Richardson, No. 607,884, July 26, 1898, Paving, Concrete.

Claims 1 and 3, therefore, are rejected upon the above patent or upon the patent to Murdock, 394,126, Dec. 4, 1888, Paving Concrete.

Claims 2 and 4 are rejected upon these references in view of the patent to Jones, No. 169,005, Oct. 19, 1875, Paving, Concrete.

CAMPBELL,

Ex.

F.L.E.

Serial No. 60450, Paper No. 1.

Dated June 20, 1901.

F. J. WARREN.

Serial No. 60450 Paper No. 2
Amend't. .A
Filed Feb. 12, 1902.

UNITED STATES PATENT OFFICE.

Examiner's Room 207.

Frederick J. Warren. PAVEMENTS.
Filed May 16, 1901. Ser. No. 60,450.

35 Court St., Boston, Mass.
February 5, 1902.

Commissioner of Patents,
Washington, D. C.

Sir:

We have Office Letter of June 20th in this case and in reply would say that from the nature of the references cited we are of the opinion that we have not made clear the nature of the applicant's present invention.

He had no intention of claiming the subject matter of any of the references. His invention consists in a new tpye of bituminous pavement, one in which the mineral element, if it may be so termed, plays a much more important and valuable part than it has ever before played in any bituminous street pavement. It in fact dispossesses the functions of the prior uses of bitumen in that it forms the principal part of the pavement and is intended to receive the wear to which the pavement is subjected, relegating the bitumen to the secondary position of filling up the voids which cannot be filled with mineral particles. To accomplish this the inventor makes such a selection of mineral particles from particles of the very finest nature to pieces of substantial size often

two inches in diameter and associates these pieces uniformly together according to a definite schedule of proportions, he having ascertained that the lowest percentage of voids is obtained in this way and for the purpose of securing a mineral foundation which is stable in and of itself and one that shall have the lowest or substantially the lowest extent of voids, therefore requiring the smallest amount of bitumen for filling them.

The application is amended as follows:—

SPECIFICATION.

Page 4, lines 7 and 14 change "metal" to | mineral. |

The claims are erased and the following substituted:

A 1. A wearing layer of street sheet pavement having a body of mineral ingredients varied as to size from a powder to pieces larger than ¼ of an inch in diameter bearing the proportions to each other herein indicated, uniformly mingled together and requiring approximately the smallest percentage of bituminous composition to fill the voids therein which would otherwise exist when laid, and said bituminous composition applied to the ingredients before they are laid and serving in the layer to fill the voids, combine and unite together the ingredients, and whereby a wearing layer is obtained which was approximately the largest percentage of mineral ingredients combined with approximately the smallest percentage of bituminous composition, all as and for the purposes set forth.

Sub. B Feb. 24–1903

2. A wearing layer of a street sheet pavement having as a base a body of mineral ingredients varied as to size bearing such proportions to each other and so uniformly mingled together as to provide a foundation the stability of which is inherent and in which the percentage of voids is reduced to near a minimum, and a bituminous composition for combined with filling said voids, ~~applied to~~ Λ the mineral ingredients before they are laid and ~~and~~ applied with them layer to a proper foundation whereby a wearing ~~section~~ Λ is obtained which has approximately the largest percentage of mineral ingredients which can be used, combined with approximately the smallest percentage of bituminous composition all as and for the purpose set forth.

3. A wearing layer of a street sheet pavement having as a base a body of mineral ingredients, varied as to size, bearing such proportions to each other and so uniformly mingled as to provide a structure the stability of which is inherent, and in which the percentage of voids is reduced to near a minimum and a bituminous composition filling said voids, combining with and uniting together the ingredients whereby a wearing layer is obtained which has approximately the largest percentage of mineral which can be used combined with approximately the smallest percentage of bituminous composition, and a thin finishing coating of relatively clear non-mineralized bituminous medium applied and united layer to the upper surface of said wearing Λ ~~section,~~ as and for the purpose set forth.

4. A street pavement comprising a suitable sub-foundation and a wearing water-proofing ~~metal~~ layer mounted on and attached to said foundation, comprising a body of mineral ingredients varied as to size, bearing such proportions to each other and so uniformly mingled throughout the mass as to provide a structure the stability of which is inherent, and in which the percentage of voids is reduced to near a minimum, and a bituminous composition for filling said voids, applied to the mineral ingredients before they are laid and combined with them upon the sub-foundation, whereby a wearing layer is obtained which has approximately the largest percentage of mineral which can be used ~~with~~ and approximately the smallest percentage of bituminous composition, the whole forming a waterproof covering to the sub-foundation, as and for the purposes set forth.

Very respectfully,
CLARKE & RAYMOND,
Attorneys for Fred J. Warren.

U. S. Patent Office. Filed Feb. 12, 1902. Division XV.

2—260

Div. Room No. 207
Address only
"The Commissioner of Patents,
Washington, D. C."

Serial No. 60, 450 Paper No. 3
Paper No. Rej.
All communications respecting this application should give the serial number, date of filing, and title of invention.

M. A. M.

DEPARTMENT OF THE INTERIOR
UNITED STATES PATENT OFFICE
WASHINGTON, D. C.,

February 25, 1902.
MAILED " " "

DIVISION 15.

Frederick J. Warren,
c/o Clarke & Raymond,
35 Court Street, Boston, Mass.

Please find below a communication from the EX-
your
AMINER in charge of ~~the~~ application ~~of~~ Serial No. 60,450, filed May 16, 1901, for Pavements.

F. I. ALLEN.
~~E. B. MOORE,~~
Commissioner of Patents.

Case considered as amended on the 10th instant.

The claims are rejected on Warren, No. 675,430, June 4, 1901, that patent discloses mineral ingredients varied as to size from a powder to pieces larger than one quarter of an inch in diameter, &c.

CAMPBELL,
Examiner.

Serial No. 60450 Paper No. 4

U.S.PATENT OFFICE
FILED
FEB 24 1903
Division XV.

Amend't. B
Filed Feb. 24, 1903.

UNITED STATES PATENT OFFICE.
Examiner's Room No. 207.
Frederick J. Warren.
Filed May 16, 1901.

PAVEMENTS.
Serial No. 60,450.

---

35 Court St., Boston, Mass.
February 18, 1903

Commissioner of Patents,
Washington, D. C.

Sir:—

In reply to the last Office Letter in this case we would say that the applicant allowed the Warren patent cited in this case to go to issue only after the present case was filed and with a complete knowledge of its contents, and no reason is now seen for re-issuing it to cover the matter of this application for the following reasons:—

The patent No. 675,430 is drawn to a complete pavement or roadway structure from the surface to the foundation. The Examiner is respectfully referred to the statement of invention therein as to the correctness of this assertion. The present case is not drawn to an entire pavement or structure but merely to a surfacing layer or mixture. This mixture could be applied to many other foundations than that disclosed in patent No. 675,430, or indeed without any special foundation. On the other

hand many surfacing mixtures or layers could be applied to the foundation claimed in No. 675,430. It was for these reasons that the applicant doubted the propriety and feasibility of claiming any specific surfacing *per se* in No. 675,430.

The Examiner's attention is directed to the claims of the Warren patent cited. He will note that claim 1 is drawn to a rather specific statement of a surfacing layer as applied to a prepared foundation and as watertight to protect said foundation. This claim evidently includes the foundation; it may be in a rather inferential manner but none the less clearly. The construction that the courts place upon such claims is now well settled. As regards claim 2, the Examiner will note that it is clearly drawn to the entire structure. Except for the last three lines of claim 1, such claim might be considered a sub-combination of the matter presented in claim 2.

Then as to both statement of invention and claims, No. 675,430 is drawn to a complete pavement structure.

Furthermore the Warren patent cited could not possibly be a reference, because even the surfacing described in that patent is different in some respects from that claimed in the present application. The Examiner will note the correctness of this statement upon consideration of the various grades of ingredients and proportions or percentages stated in the two cases. In the present case for instance much more material passes at a ½″ mesh and is caught upon a ¼″ mesh than in the patent.

The Examiner is well aware that when two applications to different species are concurrently pending in the Office, the applicant may elect in which case to present his broad claims; and the issue of a patent on the application, not presenting the broad claims, cannot affect the applicant's right to include such claims in the case remaining in the Office.

In view of the above, it is thought that the Warren patent No. 675,430 will be withdrawn as a reference in this case.

The only other patent cited which it is thought worth discussing is the Richardson patent. This patent would seem to have no bearing on the claims now in the case.

The Examiner will note that the mineral mixture of Richardson resembles the applicant's in one way only, that is, in having particles of various sizes and grades. Applicant is not seeking to claim any such broad idea. Applicant states distinctly that the bulk of his grades are within certain limits and he sets the limits. Of his material 50–80% will not pass through a ¼" mesh while only 3% is an impalpable powder. Tichardson on the other hand states (in line 86, P. 1) that but a small proportion of his material is of large size. In the first paragraph ending on the top of page 2, Richardson in speaking of his various grades emphasizes this statement in a more specific matter. In the second paragraph, same page, he says that "not more than 15% of the material used should be so large as to fail to pass a forty mesh, prefer-

ably less, and but a small amount, or none, should fail to pass the ten and twenty mesh sieves." In the third paragraph, same page, not 7% passes the forty mesh and only ½ % the ten mesh.

The great bulk of applicant's material on the other hand lies above the ¼" mesh.

It is therefore apparent that Richardson represents a grade of material differing far more radically from applicants than he differs from the prior art. Richardson's finely granulated material lacks the inherent stability of applicant's material. A heavy weight passing through it would leave a furrow. Where this stability is lacking a comparatively hard and rigid binder is necessary to maintain the material in place. Such a binder is naturally subjected to an amount of wearing comparable with that to which the mineral itself is subjected, and to properly perform its functions the binder can contain but little of the permanent softening oils. The great advantages of such oils for lending life and elasticity to pavements are too well known to be discussed. Owing to their softening qualities it has however, been heretofore impossible to use them to anything like the extent that would be otherwise desirable. The rigidity of applicant's mineral structure permits of the free use of such oils.

Another feature of applicant's invention as heretofore stated resides in the minimum amount of voids present. As a result of these new proportions, a large area of mineral is presented for wear, and a minimum of binder is required.

In the claims herewith submitted it has been attempted to set forth the structure in a clear and definite manner, and in many instances the precise limits as to proportions and degrees have been stated.

CLAIMS.

Cancel the claims and substitute:—

Cancelled March 4–1903

B 1. A street pavement mixture composed of mineral ingredients ranging in grades from 3″ in diameter to an impalpable powder, the grades being so proportioned as to give the mineral structure sufficient sustaining power to permit the use of a bituminous binder of a quality softer than could otherwise be employed, and taking Trinidad asphalt as a basis of comparison, softer than 70° penetration by Bowen's penetrating machine, in combination with such a binder.

March 4–1903

1 ~~2~~. A street pavement mixture composed of mineral ingredients ranging in grades from 3″ down to an impalpable powder, from 50 to 80 per cent. of such mineral ingredients lying between ¼″ and 3″ in diameter, in combination with a bituminous binder.

"

2 ~~3~~. A street pavement mixture composed of mineral ingredients of several grades from an impalpable powder to 3″ in diameter, over 50% of

" such ingredients being larger than ¼″ in diameter, and a bituminous binder ~~containing sufficient per-~~

" ~~manent oil to render it softer than could otherwise~~

" ~~be employed, and taking Trinidad asphalt as a~~

" ~~comparison, softer than 70° penetration by Bowen's~~

" ~~penetrating machine.~~

" 3 ~~4~~. A street pavement mixture composed of mineral or wearing ingredients, of which approximately 50 to 80% are between ¼″ to 3″ in diameter, approximately 10 to 49% between an impalpable powder and ¼″ in diameter, and approximately 1 to 3% of an impalpable powder, in combination with a binder.

" 4 ~~5~~. A street pavement mixture composed of mineral or wearing ingredients, of which approximately 50 to 80% lies between ¼″ and 3″ in diameter, approximately 10 to 49% between an impalpable powder and ¼″ in diameter, and approximately 1 to 3% an impalpable powder, in combination with a bituminous binder, of which the soft, oily constituent is sufficiently great to render the binder itself too flexible to maintain the structure rigid.

March 4–03 " 5 ~~6~~. In a street pavement, a bituminous-mineral structure, the mineral ingredients of which mixed and
are Λ of several grades, so graded to give the structure an inherent stability.

" 6 ~~7~~. A bituminous street pavement structure
" mixed
" containing Λ mineral ingredients ~~irregularly~~ ~~placed~~
" ~~with~~ ~~regard~~ ~~to~~ ~~each~~ ~~other~~ ~~and~~ of such grades as to give the structure an inherent stability.

" 7 ~~8~~. A bituminous street pavement mixture comprising a binder in combination with a mineral structure of inherent stability composed of wearing material of several grades uniformly mixed.

" 8 ~~9~~. A street paving mixture comprising a

bituminous binder in combination with a mineral structure of inherent stability.

Cancelled Mar. 26–03

9 ~~10~~. A street paving mixture of a comparatively soft and flexible binder in combination with a mineral structure of inherent stability composed a mixture of
of Λ irregular material.

" Mar. 26 –03

9 ~~10~~ ~~11~~. A street pavement wearing section composed of a mineral structure of inherent stability formed of several grades of material so proportioned as to have a per cent. of voids less than 21% of the whole, in combination with a comparatively soft bituminous binder filling said voids and rendering the whole permanent in nature and elastic and waterproof in character.

" Mar. 26 –03 " "

~~11~~ 10 ~~12~~. A mixture for street paving purposes bituminous a mixture of composed of a Λ binder and Λ mineral ingredients of several grades having less than 21% of voids, the binder being sufficient in quantity to fill the voids.

" A pavement structure composed

12 ~~13~~. Λ ~~A mixture for street paving purposes~~ of mineral or wearing ingredients and a binder softer than Trinidad asphalt of a quality softer than fixed by 70° penetration by Bowen's penetrating machine.

" Cancelled Mar. 26 –03

A pavement structure composed

13 ~~14~~. Λ ~~A street paving. mixture composed~~ of mineral or wearing ingredients and a bituminous binder softer than Trinidad asphalt of a quality softer than fixed by 70° penetration by Bowen's penetrating machine.

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14 ~~15~~. A street paving mixture composed of mineral or wearing ingredients of grades ranging from about 3″ in diameter to an impalpable powder, and a bituminous binder containing sufficient ~~permanent~~ oils to render it as soft as for comparison Trinidad asphalt, softer than 70° penetration by Bowen's penetrating machine.

16. A street paving mixture wherein the relation as to space to be occupied by the binding material is less than 21% of the whole.

structure composed of a

11 ~~15~~ ~~17~~. A street paving ∧ mixture ~~composed~~ of mineral or wearing ingredients, and a plastic binder, ~~the mineral or wearing ingredients having a~~ between the mineral ingredients being ∧ the space, ∧ less than 21% of the whole, and the plastic binder occupying said space.

Very respfy.,
CLARKE & RAYMOND,
Attys. for Fred J. Warren.

U. S. PATENT OFFICE
FILED
MAR. 14, 1903.
Division XV.
Serial No. 60450 Paper No. 5. Amend't. Filed March 4, 1903.

Amendment.

Frederick J. Warren,
Pavements;
Filed May 16, 1901. Before Examiner,
60450.

Hon. Commissioner of Patents,

Sir: In the above-entitled case please amend as follows:

In view of conference today had with the Examiner and without waiving any right to present the subject-matter hereby withdrawn in another application.

Cancel claim 1.

after

Claim 3, beginning ~~with~~ "binder" line 4, cancel to end of claim.

Claim 6, line 2, insert after "are" the words "mixed and"

Claim 7, line 1, after "containing" insert "mixed" Line 2, cancel "irregularly placed with regard to each other and"

Claim 10, line 3, insert after "of" the words "a mixture of"

Claim 12, line 2, insert after "and" the words "a mixture of"

Claims 13 and 14, cancel lines 1 to "of" and substitute "A pavement structure composed"

Claim 15, line 4, cancel "permanent"

Cancel claim 16.

Claim 17, line 1, insert after "paving" the words "structure composed of a". Line 1, cancel "composed". Lines 2 and 3 cancel the phrase "the mineral or wearing ingredients having". Line 3, insert after "space" the phrase "between the mineral ingredients being". Line 3, substitute "the" for "a" before "space."

Respectfully submitted,
FREDERICK J. WARREN,
CLARKE & RAYMOND,
His Attorneys.

2—260.

Div. Room No. 207
Address only
"The Commissioner of Patents,
Washington, D. C."

Paper No. 6
All communications respecting this application should give the serial number, date of filing, and title of invention.

M. A. M.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.
WASHINGTON, D. C.,
March 5, 1903.
Mailed " " "
Division 15.

Frederick J. Warren,
c/o Clarke & Raymond,
35 Court Street, Boston, Mass.

Please find below a communication from the EX-

your

AMINER in charge of ~~the~~ application ~~of~~ Ser. No. 60,-450, filed May 16, 1901, for Pavements.

F. I. ALLEN.

~~E. B. MOORE,~~

Commissioner of Patents.

Case considered in view of the amendments of the 24th ult., and the 4th inst.

Claims 5–11, inclusive are rejected upon British patent to Ward, 13,168 of 1900, 106 Bit. & Res., (Paving).

The reference to "Bowen's penetrating machine" in the claims is not properly supported by the specification. In their present form claims 12 and 13 are considered met in Barber, 330,197, Nov. 10, 1885, 106–31. Before final action on these two claims, however, applicant should carefully explain how the softness of his binder is determined.

CAMPBELL,

Examiner.

F. L. E.

U. S. PATENT OFFICE, MAIL ROOM,
FILED MAR 26 1903
MAR 27 1903 U. S. PATENT OFFICE.
Division.

Serial No. 60,450, Paper No. 7.
Amend't C.
Filed March 26, 1903.

UNITED STATES PATENT OFFICE.
Examiner's Room No. 207.
F. J. Warren. PAVEMENTS.
Filed May 16, 1901. Ser. No. 60,450.

35 Court St., Boston, Mass.
March 19, 1903.

Commissioner of Patents,
Washington, D. C.

Sir:—

We have Office Letter of March 5, 1903, in this case and in reply thereto we make the following amendments:—

SPECIFICATION.

Page 5, cancel the sentence beginning in line 25 and ending in line 29 and substitute therefor the following:—

C Because of the inherent stability obtained by me by the careful selection and proportioning the several grades of mineral ingredients, I am enabled to use an asphalt or bituminous uniting medium of a softer nature and at a lower temperature than could otherwise be used. This is because in my case the wear and strain falls upon the mineral ingredients and not upon the binder, which latter may

be as soft as desirable. In this application, however, I do not claim, broadly, a binder or cement of this character. I have reserved the same to be claimed in my co-pending application No. 60,819.

Claims.

Cancel claim 9.

Add the following claims:—

C1 ~~13~~ 12. A mixture of mineral or wearing ingredients of several grades, the ingredients of the descending grades in size and quantity being so proportioned to each other and to the voids existing in the larger grades as to fill the voids and impart to the structure an inherent stability, in combination with a bituminous cement or binder.

~~14~~ 13. A mixture to be used as a pavement having an inherent stability composed of mineral or wearing ingredients of several grades, the grades being thoroughly mixed and thereby uniformly distributed throughout the mass and being of sizes and quantities so proportioned that ingredients of the same grade are uniformly in contact with each other, and a bituminous cement or binder.

Cancel claims 12 and 13 and 14.

The subject matter of these claims is presented in applicants copending application 60819.

Claim 11, line 2, insert "bituminous" before "binder."

Very respectfully,

FRED. J. WARREN.

By CLARKE & RAYMOND,

Attys.

Serial No. 60450, Paper No. 8,
Letter and Affidavits.
Filed March 30, 1903.

Frederick J. Warren.
Pavements
Filed May 16, '01
#60450

U. S. PATENT OFFICE,
FILED
MAR. 30, 1903
DIVISION XV

Washington, March 30, 1903.

Commissioner of Patents,

The affidavits herewith filed in the above-entitled case carry the date of applicant's invention back of the British patent to Ward of record, and put the case in condition for allowance.

It is respectfully requested that the case be passed to issue.

Very respectfully,
CLARKE & RAYMOND,
For Applicant.

U. S. PATENT OFFICE,
FILED
MAR. 30, 1903
Division XV.

AFFIDAVIT OF FREDERICK J. WARREN IN RE APPLICATION FOR LETTERS PATENT OF THE UNITED STATES OF PAVEMENTS.

Frederick J. Warren.
Filed May 16, 1901. Ser. No. 60,450

I, Frederick J. Warren of Boston, Massachusetts, being duly sworn, depose and say that I am the above-named applicant; that for many years I have been engaged in the business of road and pavement

making, that I had conceived the subject matter of the invention contained and referred to in the above-named application and had reduced the same to a practical working basis and fully completed it before the month of July of the year 1900, and before that date I had fully and often explained the embodiment thereof to others, among them being my brother, Mr. George C. Warren, who also is an expert in the art of pavement building and therefore was fully able to understand and appreciate my description of my said invention and its value; that said description of my invention to my said brother consisted of a statement by me that I had discovered a means for imparting to bituminous pavements an inherent stability which they had heretofore lacked and that to effect this result it was necessary to employ minerals of several grades, to proportion the sizes of the smaller minerals with a regard to the size of voids between the larger minerals, and to employ sufficient quantities of such smaller ingredients to about substantially fill said voids between the larger minerals, and to supply bituminous cement in proper quantities; and I further do depose and say that I have no knowledge and do not believe that the said invention has been in public use or on sale in this country, or patented or described in any printed publication in this or any foreign country for more than two years prior to the date of my application for said Letters Patent, and that I have never abandoned the said invention.

FREDERICK J. WARREN.

New York
State of ~~Massachusetts,~~
New York
County of ~~Suffolk,~~ —ss.

Personally appeared Frederick J. Warren and acknowledged the above instrument to be his free act and deed, before me, this 25th day of March, 1903.

[Seal] F. G. CUTTER,
Notary Public.

U. S. PATENT OFFICE,
FILED
MAR. 30, 1903.
Division XV.

AFFIDAVIT OF GEORGE C. WARREN IN RE APPLICATION FOR LETTERS PATENT OF THE UNITED STATES OF PAVEMENTS.

Frederick J. Warren.
Filed May 16, 1901. Ser. No. 60,450.

I, George C. Warren of Boston, Massachusetts, being duly sworn, depose and say that I have been engaged for many years in the art of road and pavement building and am fully conversant with all the matters pertaining thereto; that prior to July, 1900, my brother Mr. Frederick J. Warren, who is the above named applicant for Letters Patent, confided and fully described to me many times the subject matter of an alleged invention of his relating to the selection of mineral ingredients for bituminous pavements or roadways; that the disclosure was verbal and consisted of a statement by the said

Frederick J. Warren that by carefully selecting mineral ingredients of certain grades and proportioning the amount of material of each grade a bituminous structure could be obtained which had great inherent stability; that in said disclosure he stated that the size of the smaller minerals was to be proportioned to the voids of the larger minerals, and that said smaller minerals were to be present in quantities to substantially fill said voids. Finally that the minerals were to be thoroughly mixed with and united by a bituminous binder; and that the practical significance and value of his said invention was fully understood and appreciated by me at that time; that I then considered the invention as complete in every particular, and it has not been changed or modified since that date; that I have read and am thoroughly conversant with the subject matter of the above entitled application for Letters Patent, and consider the pavement structure therein rejected on certain British Letters Patent to one Ward to be the structure disclosed to me by said Frederick J. Warren, as above set forth.

GEORGE C. WARREN.

New York
State of ~~Massachusetts,~~
New York
County of ~~Suffolk,~~—ss.

Personally appeared George C. Warren and acknowledged the above instrument to be his free act and deed, before me, this twenty-sixth day of March, 1903.

[Seal] F. G. CUTTER,
Notary Public.

2–181. Serial No. 60450

Division.
Communications should be addressed to
"The Commissioner of Patents,
Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
Washington, D. C., April 15, 1903.

Frederick John Warren
c/o Clarke & Raymond
35 Court St., Boston, Mass.

Sir:—Your application for a patent for an improvement in pavement, filed May 16, 1901, has been examined and allowed.

The final fee, twenty dollars, must be paid, and the letters patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least twenty days prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of 5 cents each. The money should accompany the order. Postage stamps will not be received.

Respectfully,

F. I. ALLEN,

Commissioner of Patents.

☞After allowance, and prior to payment of the final fee, applicants should carefully scrutinize the description to see that their statements and language are correct, as mistakes not incurred through the fault of the office, and not affording legal grounds for reissues, will not be corrected after the delivery of the letters patent to the patentee or his agent.

[Stamped across face:]

☞In remitting the final fee give the serial number at the head of this notice.

☞If payment is made by check or draft, the credit allowed is subject to the collection of the same.

2—327.

$20 Received
Apr 16, 1903 H
Chief Clerk, U. S. Patent Office.

MEMORANDUM
of
FEE PAID AT UNITED STATES PATENT OFFICE.

(Be careful to give correct Serial No.)
Serial No. 60450 .....190 .
Inventor: Frederick J. Warren.
Patent to be issued to: Frederick J. Warren.
Name of invention, as allowed: Pavements.
Date of payment: April 16, 1903.
Fee: $20.00.
Date of filing: May 16, 1901.
Date of circular of allowance: April 15, 1903.

The Commissioner of Patents will please apply the accompanying fee as indicated above.

CLARKE & RAYMOND,
Attorney.

Send patent to
Clarke & Raymond,
35 Court St.,
Boston, Mass.

94. PAVING,

Concrete.

1901

CONTENTS:

Application 1	papers. O. K.
1. Rej	June 20, 1901
2. Amend't A	Feb. 12–1902
3. Rej	Feb. 25. '02
4. Amend't–B	Feb. 24–1903
5. Amendt–	March 4–1903
6. Rej	Mar. 5, 1903
7. Amend't. C	March 26–1903
8. Letter & Affidavits	March 30–1903

TITLE:

Improvement in Pavement.

Plaintiff's Exhibit No. 8.

In the Supreme Court of Alberta, Judicial District of Calgary.

S. C. No. 3107.

BITULITHIC AND CONTRACTING LIMITED AND WARREN BROTHERS COMPANY,
Plaintiffs,

and

CANADIAN MINERAL RUBBER COMPANY, LTD. AND THE CITY OF CALGARY,
Defendants.

JUDGMENT.

Of the Honorable Mr. Justice Hyndman

The Plaintiffs seek an injunction and damages against the defendants for an alleged infringement of certain of their rights as licensees and patentees respectively, namely: Claims 4–5–6–9 and 11 of a certain *"new and useful improvement in street pavements"* letters patent for which were duly granted pursuant to the "Patent Act" of the Dominion of Canada, on the 5th day of July, 1904, Numbered 88,116, in favor of Frederick John Warren and his assigns, giving him the exclusive right, privilege and liberty within Canada of making, constructing, manufacturing and vending the said improvements, which patent is still in force. By assignment all the right, title, estate and interest in and to the said Letters Patent was granted to the Plaintiffs, Warren Brothers Company and the Plaintiffs, Bitulithic and Contracting, Limited, are the sole licensees within Alberta of their co-plaintiffs.

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Warren Brothers Company also possess the same patent rights throughout the United States of America and have done a very large business either by themselves or through licensees both in Canada and the United States, and the case is a most important one for the Plaintiffs as well as for the City of Calgary and other communities in Alberta affecting, as it does, their right to construct such pavement municipally or through other contractors, for, in

addition to the question whether plaintiffs' patent has been in fact infringed upon, the defendants also challenge the validity of the patent itself. The case is therefore entitled to very careful consideration.
* * * *

The defendants, the Canadian Mineral Rubber Company, undertook to and did construct the alleged infringing pavement under a contract with the City of Calgary, the circumstances in connection with which are briefly about as follows:

In March, 1912, the defendant City advertised for tenders for pavement to be constructed that year. Several tenders were presented, amongst them being those of the Bitulithic and Contracting, Limited, and the defendant Company. One Doctor Elliott, as agent for defendant Company, appeared before a meeting of the City Council and openly offered to construct pavement identical with a pavement which the plaintiffs, Bitulithic and Contracting, Limited, had laid down in Calgary in 1910 and 1911 and which plaintiffs allege was their patented pavement. Mr. McPhail, the manager of the Bitulithic and Contracting, Limited, was also present and pointed out to the Council in the presence and hearing of Dr. Elliott that their pavement was patented, and that if defendants proceeded to construct such a one his company would take legal proceedings to enjoin them from so doing. Dr. Elliott contended that such patent was not valid and said that he would undertake to fight any claim the Bitulithic and Contracting Company might set up; that he

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knew it was a patented pavement, but such patent "was not worth the paper it was written on." Mr. Child, the then City Engineer, was also present and drew the attention of the Council to the same point. It was eventually decided that a contract be let to the defendant Company to construct one hundred thousand yards of pavement under specifications identical with those of Bitulithic and Contracting, Limited, in 1910 and 1911 and at the suggestion of Mr. Child a clause was inserted in the formal contract dated the 9th of April, 1910, Exhibit 7, which reads as follows:

"26. By reason of the fact that the contractor "agrees by the specifications attached to and form- "ing part of this contract to lay down pavement "similar to Warren's bitulithic pavement recently "laid down in the City by the Bitulithic and Con- "tracting, Limited, it is distinctly agreed and un- "derstood by and between the contractor and the "corporation that if any legal proceedings are insti- "tuted against the contractor or corporation or both "for an infringement of any patent, and as a con- "sequence thereof the work comprised under this "contract is stopped, discontinued or interfered "with by order of a court or judge for a period of "twenty days, whether consecutive or not, the cor- "poration shall have the right to cancel this con- "tract at any time thereafter by giving written no- "tice to that effect in a prepaid registered letter "addressed to the contractor at Calgary, Alberta, "and thereupon all further rights of the contractor

"under this contract shall cease and determine and "the corporation shall have the right to take posses- "sion of the work and complete the same in the "manner provided in Section 16 hereof, and the "contractor agrees to indemnify the corporation "against all claims, damages, suits or actions "brought against the corporation for infringement "of any patent by the contractor and any sums for "which the corporation may be liable shall, if not "paid forthwith by the contractor, be a charge on

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"the bond accompanying this contract. In the "event of the commencement of any actions or pro- "ceedings against the corporation whether the con- "tractor is a party or not, the corporation hereby "gives and grants to the contractor the carriage and "conduct of the same in the name and on behalf of "the corporation and at the contractor's sole cost "and expense."

Construction was begun and the plaintiffs applied to my brother Stuart for an injunction restraining further work, but instead of enjoining defendants it was ordered that moneys which would fall due from time to time from the City under the contract be paid into Court leaving Plaintiff's remedy in damages alone. The defendant Company continued the work which was not completed until some time in 1914.

Assuming for the time being that the Plaintiffs' patent is valid I will consider first whether or not the defendants in fact infringed their rights. Plaintiff put in evidence subject to objection, Ex-

hibits 10 and 11, being reports from J. W. Howard, an engineer of New York, to defendant, citing with reference to the composition of the pavements as laid in Calgary by both Bitulithic and Contracting, Limited, and the defendant company tending to prove the similarity of both pavements, and that they were constructed according to the patent.

Mr. Howard was not an employee of the City, but merely acted as consulting engineer and was paid for services rendered in specific cases only. My opinion under the circumstances is that these reports are not properly admissible, and I uphold Mr. Biggar's objection.

But to my mind even without this evidence there is ample testimony which establishes infringement.

According to witnesses Child, the Ex-Engineer, and Field, the Chemist of the defendant City, the pavement of the defendant Company was doubtless constructed according to the plan or method described in Plaintiff's patent. Field says he checked the weights and saw the batches of mineral aggregate from time to time and that the specifications

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were observed carefully and Craig says the same thing as to following the specifications. I am of opinion that the ingredients employed correspond to the approximate quantities of the materials as described in the patent. The evidence is quite satisfactory that the result was similar to plaintiffs' pavement laid the previous year. The specifications used were similar to those of the plaintiffs in laying the "Bitulithic." Therefore if the specifi-

cations are the same as were used in manufacturing plaintiffs' protected pavement and comprise the method or scheme of the patent, there is no doubt in my mind that the defendants are guilty of infringement.

In considering the question of validity, it is necessary to look at the whole of the specifications and claims which I set out fully at the conclusion of the judgment.

The United States Patent which is identical with the one in question, has been the subject of litigation in several States of the Union, and Plaintiffs, Warren Brothers Company, have in each case been successful in establishing validity of their Patent. The Canadian Patent Law has, to a large extent, been moulded after the United States Laws rather than the English and decisions in our Courts have followed the American rather than the English in many respects.

In England it appears the Plaintiffs must establish, at least, a *prima facie* case of novelty, sufficiency and utility. In the United States the patent carries with it a presumption to this effect and the Canadian decisions appear to have followed in this respect and I so hold in this action.

Copeland v. *Lyman,* 90 O. R. 908. Fisher and Smart on Patents, 215 to 225 and the cases cited there.

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The onus, therefore, is upon the defendants to prove want of novelty, sufficiency of specifications and utility. I held at the trial that it was incum-

bent on the plaintiffs to prove manufacture as required by the Statute which they did to my satisfaction.

The only remaining points to be decided then are as to (1) Novelty, (2) Sufficiency and (3) Utility.

The Invention relates to an "improvement in street pavements" (not a process) which comprises a base of mineral matter and a plastic uniting medium consisting of a natural or artificial asphalt or coal tar composition which are intimately associated together and used as the upper or top surfacing of the road bed. Validity must be decided according to the state of knowledge at the date of the patent (*Vidal* v. *Levinstein,* 29 Rep. Pat. Cas. 259). It is therefore necessary to ascertain what anticipation there has been by any of the known practical methods of construction of pavements considering it not as of the present day, but during the period immediately prior to that of the Plaintiffs' patent. On the evidence I cannot find that there had been any pavements similar in construction to that of the Plaintiffs'. It is quite true that density and stability had been for many years considered most desirable and in fact were sought to be accomplished in various countries, but there does not appear to have been any fixed or known working scheme which would insure it with any degree of certainty. The old methods included granite, stones and wood blocks, brick, as also macadam, tar asphalt and sheet asphalt. The form which most approaches "Bitulithic" appears to have been sheet asphalt. The old familiar macadam was made of

irregular sizes of fairly large broken stone and laid usually in three uniform layers. These layers were crushed down with heavy rollers and on the top small stones, stone dust, or street sweepings were rolled into this which formed a temporary cement. The mixture contained a large percentage of voids

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and would absorb dust, moisture, deposits of horses, etc. The structure changed continually according to the amount of traffic. It became very dusty in dry weather and muddy and slippery after rain and was also unsanitary. Tar macadam was the ordinary macadam structure with a coating of tar. Tar concrete had never been used for street pavements but only for sidewalks. Tar macadam and macadam are often the foundation for the plaintiffs' pavement. Sheet asphalt is composed merely of sand, the interstices being filled with asphalt cement. It is subject to the disadvantage of being too hard and brittle in winter and liable to fracture under traffic as well as being very slippery in wet weather, especially so on slopes. The voids, too, in sand run from 30 to 38%, requiring therefore a very large percentage of expensive cement to fill the spaces. It appears without doubt that the great object in view was the production of a waterproof pavement with the least number of voids; inherent stability and resistance to wear as well as being dustless, noiseless and sanitary and free from liability to fracture.

It appears from the evidence that Warren, the Inventor—who was a paving contractor—made the

business his life work and carried on many experiments. The result of his experiences was that he regarded all pavements up to this time as wrong, owing to the arrangement of the mineral matter and claimed that he discovered by experiment that the usual method, namely, a mixture of sand or fine gravel united by the plastic asphalt vehicle contained a larger percentage of voids than in a mixture of a relatively larger size. His invention was the discovery that an aggregate of large and small pieces of stone graded down to an impalpable powder mixed together in certain proportions would produce a mixture having less than 21% of voids and when so assembled and compacted together would form a dense solid homogeneous body with the smallest percentage of voids and possessing the

highest degree of stability and one in which the largest and smallest pieces are associated with each other indiscriminately throughout the structure and one which because of the sizes of the pieces and their arrangement with respect to each other offers the smallest areas of surfaces for the attachment of the plastic composition to them so that not only is a superior binding effect or union obtained but a smaller quantity of the plastic composition is necessary for the purpose of obtaining the superior result or product. A good deal of evidence was given on the subject of stability. It is not claimed by the inventor that his mineral aggregate has absolute or perfect stability but merely a high degree or greater than any other known pavement. An-

other point of value is the fact that as a result of this arrangement small particles of stone, sand or impalpable powder being used to fill the voids and being much cheaper than asphalt a large saving in cost is the effect in this way. * * *

It seems to me from the evidence that, although it might be admitted that other pavements, *e. g.* macadam may possibly possess as great a density and great stability still the process is altogether different and full of uncertainty. There is no way of ascertaining the density until after it was laid and treated and rolled on the street. The Bitulithic as to all these features is prepared and may be known in advance and is laid down with at least an approximate certainty of its density. The inventor reduced the composition of the mineral aggregate to a certainty which before was uncertain and usually mixed in a haphazard way "hit or miss" as Engineer Craig put it, and this both as to quality and quantity of the mineral ingredients.

Defendants put in as Exhibit 12, copy of United States Patent Number 104325 dated 14th June, 1870, granted to Gabriel Leverick and A. H. Emery as evidence of anticipation of plaintiffs' patent. A careful perusal, however, leads me to the opinion

that although the principle or idea very much resembles that of the patent in question, yet it is plainly distinguishable inasmuch as stress is laid more on the treatment or quality of the tar itself rather than the composition of the mineral aggregate.

(See especially paragraphs 6 and 7 of Exhibit 12.)

I have come to the conclusion therefore that the Plaintiffs' pavement was, at the date of the Letters Patent, not anticipated by any other known at that time and that its novelty has not been successfully challenged.

As to the sufficiency of the specifications the law seems to be well settled that in return for the monopoly or privilege which is granted him in respect to his inventions, the patentee must say clearly and plainly what his invention is so that others practicing the art may learn and use it with facility at the expiration of the term of the Patent—"Uberrima Fides" is required in this respect.

It does not necessarily mean that any person whomsoever may be able to apply and understand them, but that any workman acquainted with the art to which the invention belongs might make, construct and put the invention into practice. In the case at bar it would, I think, mean any person whose business was constructing pavements or analogous works. It would not, I think, include a common laborer doing a part of the rough work of construction, but rather a practical contractor, foreman or overseer.

He must not claim too much, that is, more than his specifications comprise, otherwise his patent will be invalid.

Sufficiency being presumed, I do not see that the defendants have been successful in pointing out and proving wherein the specifications are defec-

tive. The evidence seems to be much to the contrary. The very fact that the defendant company was able to successfully construct the pavement under their contract without apparently any difficulty tends to prove this very point. * * *

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It was argued that the use of certain machinery was absolutely necessary to success in producing the result and the Inventor should have named and described carefully the various machines to be used, not only for testing, but also for the process of mixing the mineral ingredients. As these things change from time to time, I hardly think it incumbent on the patentee to go into details in this regard. The main features are the materials and the proportions thereof employed. Some of the machines for grading and separating the stone and powder are themselves patented inventions and would thus be available to any one in the trade in the usual way. Moreover the witness, George C. Warren, testified that the pavement has been produced without the use of the machines. Testing the material appears to be a most important feature in order to arrive at a satisfactory conclusion as to the exact proportions which ought to be used, but any one skilled in the work ought to be able to do this without the necessity of having the specifications encumbered with details of the testing instruments and operations. Doubtless different operators would use different methods and methods will continue to change from time to time. The evidence of Mr. McPhail was to the effect that some

of the cities in which they performed work they did not own or operate crushing machines but purchased the material from other concerns, the plaintiffs merely having to mix the various grades in the proper proportions.

As to utility I need say little. There is ample evidence that it is a very useful invention and according to City Engineer Craig, and other witnesses, the Bitulithic Pavement is a highly satisfactory one. I hold also that the invention is proper subject matter for a patent.

I therefore find that the patent is valid and has been infringed—and the plaintiffs entitled to an injunction. There will be a reference to the Clerk

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of the Court to ascertain what damages the plaintiffs have sustained by reason of such infringement, any party being at liberty to apply from time to time for further directions. * * *

Dated March 16th, 1915.

J. D. HYNDMAN,
J. S. C.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 10.

EXTRACTS FROM PLAINTIFF'S EXHIBIT No. 10—CONTRACT BETWEEN OSKAR HUBER AND STATE HIGHWAY COMMISSION OF OREGON FOR PAVING ON THE PACIFIC HIGHWAY IN JACKSON COUNTY, OREGON, FROM ASHLAND TO GREEN SPRINGS MOUNTAIN ROAD.

This contract was executed May 6, 1919, by the State Highway Commission, party of the first part, and Oskar Huber, party of the second part, and provides for the paving by said Huber of the "Ashland to Green Springs Mountain Road section of the Pacific Highway" with "Standard Bitulithic Pavement" (p. 83).

This contract contains the same provisions as are contained in the contract Plaintiff's Exhibit 9 quoted above, to which reference is hereby made.

Plaintiff's Exhibit No. 11.

EXTRACTS FROM PLAINTIFF'S EXHIBIT No. 11—CONTRACT BETWEEN OSKAR HUBER AND STATE HIGHWAY COMMISSION OF OREGON FOR PAVING SALEM–DALLAS HIGHWAY IN POLK COUNTY, OREGON.

This contract was executed July 8, 1919, by the State Highway Commission, party of the first part, and Oskar Huber, party of the second part, and provides for the paving by said Huber of the Sa-

lem-Dallas Highway in Polk County, Oregon, with "Standard Bitulithic Pavement."

This contract contains the same provisions as are contained in the contract Plaintiff's Exhibit 9 quoted above, to which reference is hereby made.

Plaintiff's Exhibits 10 and 11 offered and received in evidence were contracts for the Ashland-Green Springs Mountain Road section and the Salem-Dallas Highway, respectively, and their provisions are identical *mutatis mutandis* with those of Exhibit 9 except that the specifications for the Salem-Dallas Highway provided for the use of crushed gravel instead of crushed rock, and in the bid which was accepted was a statement as to the number of square yards to be laid with standard bitulithic pavement, Type F, with a statement opposite said item, which statement was as follows: "Based on using broken stone and gravel in the mineral aggregate and asphalt to be furnished by commission."

Plaintiff's Exhibit No. 12.

FORM 299-1-13-2,000

State Oregon

City [illegible]

(1)

Street [illegible] 19[illegible]

Date														
Lab. No.														
B. C.— D														
L														
21 flux														
24														
55														
B														
Surface Bit. Plant Hydr.														
Lab. "														
" *Dow														
" *Cg														
F. C. Bit. Pen. Hydr.														
" *Dow														
" *Cg														
Bin 6														
5														
4														
3														
2														
1														
Dust														
B. C.—														
Bitumen %	6.4	6.1	5.9	5.9	6.3	7.0	7.2	6.2	6.6	6.3	6.1	6.6	6.1	6.1	6.6
~~On 1½"~~ %	7.0	~~2.0~~	5.5	11.7	37.6	39.3	33.3	25.2	40.6	30.2	33.1	21.9	37.8	21.9	43.1
Pass. 1½" %															
1" %															
¾" %															
½" %	21	24	13	24.7	20.7	23.7	27.0	26.5	19.3	22.3	20.5	25.4	19.5	25.2	14.2
⅜" %	13.0	11.5	9.4	10.9	15.7	14.2	12.7	14.9	13.2	13.8	12.1	11.9	12.6	12.2	6.5
8 %															
10 %	10.0	10.5	11.9	10.3	11.9	13.4	13.9	15.0	14.0	15.6	13.9	16.0	14.5	12.4	14.4
20 %															
30 %															
40 %	5.2	3.9	4.3	5.4	4.8	6.4	5.1	6.9	4.0	5.6	5.6	6.7	4.9	4.6	5.6
50 %															
80 %	1.6	1.0	1.2	1.3	1.3	2.3	1.4	2.6	1.2	1.9	1.4	1.4	1.4	1.4	2.0
100 %	4.9	3.0	3.1	3.0	3.6	5.0	3.1	4.8	3.0	4.0	3.0	4.2	3.2	3.2	3.2
200 %	4.7	2.8	4.0	2.5	4.5	4.9	3.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.0	4.4	4.7
Hrs. Mixed 10	18.2	22.5	24.1	22.7	26.0	22.9	27.0	[illegible]	[illegible]	[illegible]	[illegible]	33.9	27.5	26.0	33.9
Batches "															
Car tracks															
% grade															

No. 1.1

UNITED STATES CIRCUIT COURT OF APPEALS
FOR THE NINTH CIRCUIT
FILED
JAN 2 - 1924
F. D. MONCKTON.
CLERK.

U.S. DISTRICT COURT
DISTRICT OF OREGON
FILED
JUN 8 1922
CLERK

Pltf. Ex. 46

Form 280 4-2-13 1m

V

State Oregon
City Jackson County

Street

19 17

Date	9/13	9/15	9/16	9/17	9/18	9/19	9/20	9/22	9/23	9/24	9/27	9/29	9/30	10/2	10/3	10/4
Lab. No.	01761	01776	01789	01790	01811	01911	01841	01879	01879	01911	01961	01990	02004	02024	02035	02092
B. C. = D	✓	✓	✓	✓				✓	✓			✓				
L					✓								✓			
21 flux																
24																
55																
B																
Surface Bit.																
Plant Hydr.																
Lab. "																
" °Dow																
" °Cg																
F. C. Bit.																
Pen. Hydr.																
" °Dow																
" °Cg																
Bin 6																
5																
4																
3																
2																
1																
Dust																
B. C. =																
Bitumen %	6.1	6.0	6.3	6.1	6.7	6.6	6.9	6.1	6.2	6.1	6.0	5.0	5.9	7.0	6.8	6.1
~~On 1½"~~ %	33.4	36.9	41.2	39.2	33.8	37.9	39.6	[illegible]	36.9	39.6	43.6	49.9	53.3	50.1	38.6	40.4
Pass. 1½" %																
1" %																
½" %																
½" %	17.2	22.5	20.6	19.5	22.5	19.1	13.1	16.2	17.0	16.3	16.0	18.5	13.6	12.9	13.6	16.6
¼" %	13.5	17.1	10.1	10.3	12.2	12.2	10.3	11.6	13.6	11.1	11.9	7.1	10.9	10.5	13.1	13.9
8 %																
10 %	17.0	13.5	12.4	12.6	14.3	16.4	15.2	11.9	17.1	11.7	13.8	11.1	9.6	13.1	15.1	13.9
20 %																
30 %																
40 %	5.2	5.6	4.7	5.5	6.2	6.2	5.7	5.6	5.3	4.7	5.6	3.9	4.7	5.4	7.3	5.8
50 %																
80 %	2.9	1.7	1.4	2.6	1.5	2.2	1.5	2.6	1.2	0.7	1.5	1.2	1.6	1.6	2.3	1.0
100 %	4.2	3.6	3.6	4.5	4.2	3.6	4.3	3.3	3.3	3.0	3.0	2.2	2.2	2.9	4.1	4.0
200 %	4.3	4.1	5.3	5.5	4.7	2.4	6.0	3.5	5.8	2.2	4.6	3.5	4.1	3.5	6.0	4.4
Hrs. Mixed	33.6	28.5	27.4	30.1	31 ✓	30.8	33.0	35.9	27.7	22.3	28.5	21.9	22 ✓	26.5	26.8	29.1
Batches "																
Car Tracks																
% grade																

139

Form 290 6-2-18 1m

State Oregon

City Jackson County

Street

1919

Date	10/6	10/7	10/8	10/9	10/10	10/11	10/13	10/14	10/15	10/16	10/17	10/20	10/21	10/23	10/24	10/25
Lab. No.																
B. C. = D																
L																
21 flux																
24																
55																
B																
Surface Bit. Plant Hydr.																
Lab. "																
" °Dow																
" °Cg																
F. C. Bit. Pen. Hydr.																
" °Dow																
" °Cg																
Bin 6																
5																
4																
3																
2																
1																
Dust																
B. C. =																
Bitumen %	6.0	6.1	7.0	6.0	6.1	6.1	6.0	6.1	6.1	6.1	6.2	6.0	6.3	6.2	6.6	6.0
~~On 1½"~~ %	48.5	51.6	32.7	38.6	51.8	52.5	40.1	52.3	38.9	46.9	42.6	42.8	49.0	47.7	49.0	48.9
Pass. 1½" %																
1" %																
¾" %																
½" %	9.5	16.7	14.2	16.0	13.5	14.0	12.9	9.6	25.2	13.9	12.3	15.2	10.5	12.9	10.8	12.2
⅜" %		9.3	17.9	6.7	10.2	7.0	12.0	10.8	10.	9.8	12.2	12.3	10.9	11.3	9.5	10.6
8 %																
10 %	14.9	11.1	16.3	15.3	11.3	11.8	17.8	13.7	10.9	13.4	15.2	14.1	16.5	15.1	15.8	14.1
20 %																
30 %																
40 %	6.3	3.6	9.1	6.0	5.3	3.9	7.1	5.4	3.8	6.6	7.2	5.7	5.9	5.1	6.4	5.9
50 %																
80 %	1.5	0.9	2.0	1.4	1.4	1.4	1.7	1.6	0.9	2.0	1.9	2.0	1.6	1.2	1.4	1.2
100 %	3.5	2.9	4.3	3.1	3.2	3.0	3.9	3.1	2.5	3.6	4.4	3.8	3.2	2.9	3.2	3.0
200 %	4.0	3.9	4.8	3.9	3.9	4.0	4.5	3.6	3.8	4.8	4.3	4.1	3.4	3.9	3.8	3.9
Hrs. Mixed 10	20.5	22.4	26.5	29.7	26.1	26.1	25.0	29.4	21.7	30.4	32.9	29.7	29.6	28.1	30.6	28.1
Batches "																
Car Tracks																
% grade																

40

FORM 299-1-13-2,000

Wolf

State Oregon
City Jackson Co.
19

Street

Date	10/2	10/31	11/1	11/2	11/5	11/6		
Lab. No.	07689	07691	07692	07812	07810	07811		
B. C.— D			×					
L	✓				✓			
21 flux								
24								
55								
B								
Surface Bit. Plant Hydr.								
Lab. "								
" °Dow								
" °Cg								
F. C. Bit. Pen. Hydr.								
" °Dow								
" °Cg								
Bin 6								
5								
4								
3								
2								
1								
Dust								
B. C.—								
Bitumen %	6.1	6.0	6.1	6.2	6.1	6.2	6.3	6-7.5
~~On 1½"~~ %	47.2	52.3	48.1	43.6	50.8	43.0	42.1	35-50
Pass. 1½" %								
1" %								
¾" %								
½" %	12.1	13.1	15.5	18.2	14.1	19.5	17.5	12-20
¼" %	10.9	10.2	9.0	14.2	9.2	11.0	12.0	8-12
8 %								
10 %	14.4	12.7	13.7	11.8	11.7	12.9	13.7	-
20 %								
30 %								
40 %	6.0	4.7	5.4	4.3	5.3	4.9	5.6	ok
50 %								
80 %	1.6	1.2	1.3	1.6	1.6	1.7	1.6	ok
100 %	4.0	2.4	3.5	2.9	3.3	3.6	3.5	+
200 %	3.8	3.4	3.3	3.6	4.0	3.1	4.1	ok
Hrs. ~~Mixed~~ 40	29.8	24.1	27.1	21.0	25.9	26 ✓	26.2	
Batches "								
Car tracks								
% grade								

Average (written vertically next to the last two columns)

59.6
36.3

141

79.3 84.2 ~~37.~~ 85.8

37.5
84.2
40)1960

858
372
40)2192 55

LOCATIONS:

Lab. No.____________

____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.
____________St.______side;______ft.______of______curb of____________St.

79.3 84.2 37 96 85.8

32.5
842
46) 1960
160

858
372
40) 2192 55
200
192

LOCATIONS:

Lab. No.

St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.
St. side; ft. of curb of St.

Plaintiff's Exhibit No. 17.

Portland, Oregon, May 12, 1922.

LABORATORY REPORT No. P. L. 051.

Tests made on sample of Bitulithic pavement laid by Oskar Huber in 1919 in Jackson County, Oregon, on Green Springs Mountain Road to California line section of Pacific Highway. Sample cut by A. E. Schutte, L. Price, and G. A. Jenkins on May 9, 1922, from the east side of the above road at a point one (1) mile (by speedometer reading) north of the Oregon-California line. Sample brought to laboratory by A. E. Schutte and G. A. Jenkins, May 11, 1922, and there analyzed by them on May 11 and May 12, 1922.

ANALYSIS.

Bitumen		6.9%	
Passing	1¼″	12.8%	
"	1″	16.1	
"	¾″	15.6	
"	½″	21.2	65.7%
"	4	8.9	
"	8	2.1	
"	10	5.6	
"	20	3.7	
"	30	1.7	
"	40	1.9	
"	50	2.4	
"	80	1.0	
"	100	3.1	30.4
"	200	4.4	4.4
		100.5	100.5

Percentage of Voids found in Mineral Aggregate, 16.8%.

WARREN BROTHERS COMPANY,
PORTLAND LABORATORY.
By G. A. JENKINS,
A. E. SCHUTTE.

Lab. No. PL 051
Filter 15
Mixture 1130
Total 1145
After Extr 1067
Net 78 6.9%

	Pass 1½		
	Pass 1½	12.8	
	Pass 1½	12.8	
657 on ¼	" 1	16.1	
343 P ¼	" ¾	15.6	
	" 2	21.2	657
	" 4	8.9	
	" 8	2.1	

Sp. grav.

Wt. of Pyc. full water	1615
Agg	500
Total	2115
Wt. Pyc, agg. & bal. water	1932
Displacement	183

$$\text{Sp. gr.} = \frac{500}{183} = 2.732$$

Void test

Sp. gr. matt. used (material of original sample) 2.732

" 10	5.6		Wt. of cone	1204 grams
" 20	3.7		Capacity	1000 cc
" 30	1.7		Contents solid material	
" 40	1.9		2.732 × 1000 =	2732 grams
" 50	2.4		Wt. of cone + min. agg.	3476 "
" 80	1.0		" " min. agg.	2272 "
" 100	3.1	30.4	Voids 2732 — 2272	460
" 200	4.4	4.4	460	
			% Voids ——	16.8
	100.5		2732	

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

Plaintiff's Exhibit No. 18.

Portland, Oregon, May 12, 1922.

LABORATORY REPORT No. P. L. 052.

Tests made on sample of Bitulithic pavement laid by Oskar Huber in 1919 in Jackson County, Oregon, on Green Springs Mountain Road to California line section of Pacific Highway. Sample cut by A. E. Schutte, L. Price, and G. A. Jenkins on May 9, 1922, from the east side of the above road at a point 3.6 miles (by speedometer reading) north of the Oregon-California line. Sample brought to laboratory by A. E. Schutte and G. A. Jenkins, May 11, 1922, and there analyzed by them on May 11 and May 12, 1922.

ANALYSIS.

Bitumen	6.7%	
Passing 1½"	1.9%	
" 1¼"	16.2	
" 1"	10.8	
" ¾"	13.6	
" ½"	21.4	63.9%
" 4	8.7	
" 8	1.9	
" 10	5.1	
" 20	3.5	
" 30	1.9	
" 40	2.1	
" 50	2.8	
" 80	1.4	
" 100	4.1	31.5
" 200	4.6	4.6
	100.0	100.0

Percentage of Voids found in Mineral Aggregate, 15.9%.

WARREN BROTHERS COMPANY,
PORTLAND LABORATORY,
By G. A. JENKINS,
A. E. SCHUTTE.

Lab. No. PL 052

Filter	15				
Mixture	1130				
Total	1145				
After Extr.	1069				
Net	76			6.7%	
		Pass.	1½	1.9	
On ¼	639	Pass.	1¼	16.2	
P ¼	361	"	1	10.8	
	315 4.6	"	¾	13.6	
	274 4.1	"	2	21.4	63.9
	260 1.4	"	4	8.7	

Sp. gr.

Wt. of Pyc.	1615
& agg.	500
Total	2115
Wt. pyc. & agg. full water	1930
	185

185)500(2.70

Void test

Sp. gr. material used (material of original sample)	2.70

232	2.8	"	8	1.9		Wt. of cone	1204 grams
211	2.1	"	10	5.1		Capacity	1000 cc
192	1.9	"	20	3.5		Conts. sold matl. = 2.70 × 1000	2700 grams
157	3.5	"	30	1.9			
106	5.1	"	40	2.1		Wt. cone & min, agg.	3474 "
87	1.9	"	50	2.8		" min. agg.	2270 "
0		"	80	1.4		Voids (2700—2270)	430
		"	100	4.1	31.5	% Voids $\frac{430}{2700}$	15.9
		"	200	4.6	4.6		
				100.0	100.0		

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 19.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 183.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02810, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on November 5, 1919, and laid at Station 135 plus 00 on Green Springs Mountain Road-California line section of Pacific Highway.

Analysis of P. A. 02810.

Bitumen	6.1%	
Pass. 1¼"	12.7%	
1	16.0	
¾	22.1	
½	14.1	64.9%
¼	6.8	
⅛	2.4	9.2
10	5.9	5.9
20	3.4	
30	2.4	
40	1.9	7.7
50	3.4	3.4
80	1.6	

100	3.3	4.9
200	4.0	4.0
	100.0	100.0

Percentage of voids in Mineral Aggregate, 18.01.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 182.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02649, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on October 28, 1919, and laid on Green Springs Mountain Road—California line section of Pacific Highway. (Exact location not given. Engineer's stakes missing.)

Analysis of P. A. 02649.

Bitumen	6.1%	
Pass. 1¼″	18.0%	
1	16.0	
¾	13.2	
½	12.1	59.3%
¼	7.5	
⅛	3.4	10.9
10	7.2	7.2
20	4.3	
30	2.9	
40	1.9	9.1
50	4.1	4.1
80	1.6	
100	4.0	5.6
200	3.8	3.8
	100.0	100.0

Percentage of Voids in Mineral Aggregate, 15.93.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 181.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02501, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on October 21, 1919, and laid at Station 170 plus 80 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 02501.

Bitumen	6.3%	
Pass. 1½″	1.5%	
1¼	10.0	
1	22.9	
¾	14.6	
½	10.5	59.5%
¼	7.5	
⅛	3.4	10.9
10	8.0	8.0
20	5.2	
30	3.3	
40	2.0	10.5
50	3.9	3.9
80	1.6	
100	3.2	4.8
200	2.4	2.4
	100.0	100.0

Percentage of voids in Mineral Aggregate, 15.87.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 180.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02374, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on October 15, 1919, and laid at Station 1 plus 80 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 02374.

Bitumen	6.1%	
Pass. 1¼″	4.3%	
1	12.2	
¾	22.4	
½	28.9	67.8%
¼	7.6	
⅛	2.7	10.3
10	5.7	5.7
20	3.4	
30	1.8	
40	0.9	6.1
50	2.9	2.9
80	0.9	
100	2.5	3.4
200	3.8	3.8
	100.0	100.0

Percentage of voids in Mineral Aggregate, 18.49.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 179.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02266, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on October 10, 1919, and laid at Station 21 plus 15 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 02266.

Bitumen	6.1%	
Pass. 1¼″	15.6%	
1	20.8	
¾″	15.4	
½″	13.7	65.5%
¼	7.5	
⅛	2.9	10.4
10	5.6	5.6
20	3.3	
30	2.4	
40	1.4	7.1
50	3.9	3.9
80	1.4	
100	3.2	4.6
200	2.9	2.9
	100.0	100.0

Percentage of voids in Mineral Aggregate, 15.89.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 178.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02114, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on October 6, 1919, and laid at Station 41 plus 50 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 02114.

Bitumen		6.0%	
Pass.	1¼″	14.9%	
"	1	19.6	
"	¾	14.0	
"	½	9.8	58.3%
"	¼	8.2	
"	⅛	3.0	11.2
"	10	7.1	7.1
"	20	4.6	
"	30	3.2	
"	40	1.8	9.6
"	50	4.5	4.5
"	80	1.5	
"	100	3.8	5.3
"	200	4.0	4.0
		100.0	100.0

Percentage of voids in Mineral Aggregate, 14.62.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 177.

Tests made to determine percentage of voids in mineral aggregate of P. A. 02004, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 30, 1919, and laid at Station 67 plus 75 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 02004.

Bitumen		5.9%	
Pass.	1½"	3.4%	
"	1¼	12.8	
"	1	23.4	
"	¾	13.7	
"	½	13.6	66.9%
"	¼	7.7	
"	⅛	3.2	10.9
"	10	5.0	5.0
"	20	2.9	
"	30	1.7	
"	40	1.0	5.6
"	50	3.7	3.7
"	80	1.6	
"	100	2.2	3.8
"	200	4.1	4.1
		100.0	100.0

Percentage of voids in Mineral Aggregate, 17.87.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 176.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01879, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 23, 1919, and laid at Station 86 plus 00 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01879.

Bitumen		6.2%	
Pass.	1¼″	7.3%	
"	1	13.8	
"	¾	15.8	
"	½	17.0	53.9%
"	¼	10.0	
"	⅛	3.4	13.4
"	10	9.5	9.5
"	20	4.9	
"	30	2.7	
"	40	1.5	9.1
"	50	3.8	3.8
"	80	1.2	
"	100	3.3	4.5
"	200	5.8	5.8
		100.0	100.0

Percentage of voids in Mineral Aggregate, 16.14.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 175.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01810, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 18, 1919, and laid at Station 487 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01810.

Bitumen		6.7%	
Pass.	1½″	0.0%	
"	1¼	3.2	
"	1	8.6	
"	¾	22.0	
"	½	22.8	56.6%
"	4	9.0	
"	8	3.2	12.2
"	10	7.3	7.3
"	20	4.4	
"	30	2.6	
"	40	1.7	8.7
"	50	4.5	4.5
"	80	1.8	
"	100	4.2	6.0
"	200	4.7	4.7
		100.0	100.0

Percentage of voids in Mineral Aggregate, 15.45%.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 174.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01701, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 13, 1919, and laid at Station 532 plus 25 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01701.

Bitumen		6.1%	
Pass.	1½"	0.0%	
"	1¼	8.2	
"	1	9.5	
"	¾	15.7	
"	½	19.2	52.6%
"	¼	9.9	
"	⅛	3.9	13.8
"	10	9.6	9.6
"	20	4.8	
"	30	2.6	
"	40	2.2	9.6
"	50	3.0	3.0
"	80	2.9	
"	100	4.2	7.1
"	200	4.3	4.3
		100.0	100.0

Percentage of voids in Mineral Aggregate, 17.46.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 173.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01587, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 6, 1919, and laid at Station 517 plus 00 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01537.

Bitumen	6.6%	
Pass. 1½	4.7%	
" 1¼	0.0	
" 1	3.8	
" ¾	13.4	
" 2	25.4	47.3%
" 4	13.5	
" 8	5.5	19.0
" 10	9.6	9.6
" 20	4.4	
" 30	2.0	
" 40	2.9	9.3
" 50	3.8	3.8
" 80	1.4	
" 100	4.2	5.6
" 200	5.4	5.4
	100.0	100.0

Percentage of voids in Mineral Aggregate, 17.76.

Portland, Oregon, April 10, 1922.

LABORATORY REPORT No. P. H. 172.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01544, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on September 2, 1919, and laid at Station 498 plus 75 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01544.

Bitumen		6.2%	
Pass.	1¼	3.1%	
"	1	5.8	
"	¾	16.3	
"	½	26.5	51.7%
"	4	9.6	
"	8	4.4	14.0
"	10	7.7	7.7
"	20	4.6	
"	30	2.7	
"	40	2.1	9.4
"	50	4.8	4.8
"	80	2.5	
"	100	4.8	7.3
"	200	5.1	5.1
		100.0	100.0

Percentage of voids in Mineral Aggregate, 16.55.

Portland, Oregon, April 10, 1922.

LABORATORY No. P. H. 171.

Tests made to determine percentage of voids in mineral aggregate of P. A. 01266, which showed analysis given below and which was an uncompressed sample of Bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson County, Oregon, on August 19, 1919, and laid at Station 443 on Green Springs Mountain Road—California line section of Pacific Highway.

Analysis of P. A. 01266.

Bitumen	5.9%	
Pass. 1½	4.6%	
" 1¼	2.5	
" 1	12.6	
" ¾	22.0	
" ½	24.7	66.4%
" 4	7.1	
" 8	3.8	10.9
" 10	6.2	6.2
" 20	3.3	
" 30	1.0	
" 40	2.4	6.7
" 50	3.0	3.0
" 80	1.3	
" 100	3.0	4.3
" 200	2.5	2.5
	100.0	100.0

Percentage of voids in mineral aggregate, 1903.

P H 183

Lab. No. P. A. 02810
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½		
Pass	1¼	12.7	762
"	1	16.0	960
"	¾	22.1	1326
"	2	14.1	846
"	4	6.8	408
"	8	2.4	144
"	10	5.9	354
"	20	3.4	204
"	30	2.4	144
"	40	1.9	114
"	50	3.4	204
"	80	1.6	96
"	100	3.3	198
"	200	4.0	240
		100.0	6000

Void Test

Spec. Grav. material used:

.741 × 2.84 = 2.104√
.259 × 2.75 = .712
Spec. Grav. 2.816√

Weight of cone	4365
" " " full water	6641
Capacity	2276√
Contents of no voids	6409√
Weight of cone full of Min. Agg.	9620
Min. Agg.	5255√
Voids	1154√
% "	18.01√

Lab. No. P. A. 02649
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½		
Pass	1¼	18.0	1080
"	1	16.0	960
"	¾	13.2	792
"	2	12.1	726
"	4	7.5	450
"	8	3.4	204
"	10	7.2	432
"	20	4.3	258
"	30	2.9	174
"	40	1.9	114
"	50	4.1	246
"	80	1.6	96
"	100	4.0	240
"	200	3.8	228
		100.0	6000

Void Test

Spec. Grav. materials used:

.702 × 2.84 = 1.994√
.298 × 2.74 = .816
Spec. Grav. 2.810√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6395√
Weight of cone full of Min. Agg.	9740
Min. Agg.	5376√
Voids	1019√
% "	15.93√

P H 181

Lab. No. P. A. 02501
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½	1.5	90
Pass	1¼	10.0	600
"	1	22.9	1374
"	¾	14.6	876
"	2	10.5	630
"	4	7.5	450
"	8	3.4	204
"	10	8.0	480
"	20	5.2	312
"	30	3.3	198
"	40	2.0	120
"	50	3.9	234
"	80	1.6	96
"	100	3.2	192
"	200	2.4	144
		100.0	6000

Void Test

Spec. Grav. material used:

.704 × 2.84 = 1.999√
.296 × 2.75 = .814√
Spec. Grav. 2.813√

Weight of cone	4364
" " " full of water	6640
Capacity	2276
Contents if no voids	6402√
Weight of cone full of Min. Agg.	9750
Min. Agg.	5386√
Voids	1016√
% "	15.87√

Lab. No. P. A. 02374
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½		
Pass	1¼	4.3	258
"	1	12.2	732
"	¾	22.4	1344
"	2	28.9	1734
"	4	7.6	456
"	8	2.7	162
"	10	5.7	342
"	20	3.4	204
"	30	1.8	108
"	40	0.9	54
"	50	2.9	174
"	80	0.9	54
"	100	2.5	150
"	200	3.8	228
		100.0	6000

Void Test

Spec. Grav. material used:
.781 × 2.84 = 2.218√
.219 × 2.75 = .602√
Spec. Grav. 2.820√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6418√
Weight of cone full of Min. Agg.	9595
Min. Agg.	5231√
Voids	1187√
% "	18.49√

P H 179

Lab. No. P. A. 02266
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass.	1½		
Pass	1¼	15.6	936
"	1	20.8	1248
"	¾	15.4	924
"	2	13.7	822
"	4	7.5	450
"	8	2.9	174
"	10	5.6	336
"	20	3.3	198
"	30	2.4	144
"	40	1.4	84
"	50	3.9	234
"	80	1.4	84
"	100	3.2	192
"	200	2.9	174
		100.0	6000

Void Test

Spec. Grav. material used:
.759 × 2.83 = 2.148√
.241 × 2.75 = .663√
Spec. Grav. 2.811√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6398√
Weight of cone full of Min. Agg.	9745
Min. Agg.	5381√
Voids	1017
% "	15.89√

Void Test

Spec. Grav. material used:

Lab. No. P. A. 02114

Filter .695 × 2.84 = 1.974√

Mixture .305 × 2.75 = .839√

Total Spec. Grav. 2.813√

After Extr.			%	Grams.		
Net.	Pass	1½			Weight of cone	4364
	Pass	1¼	14.9	894	" " " full water	6640
	"	1	19.6	1176	Capacity	2276
	"	¾	14.0	840	Contents if no voids	6402√
	"	2	9.8	588	Weight of cone full of Min. Agg.	9830
	"	4	8.2	492	Min. Agg.	5466
	"	8	3.0	180	Voids	936

" 10	7.1	426	% "	$14.62\sqrt{}$
" 20	4.6	276		
" 30	3.2	192		
" 40	1.8	108		
" 50	4.5	270		
" 80	1.5	90		
" 100	3.8	228		
" 200	4.0	240		
	100.0	6000		

P H 177

Void Test

Lab. No. P. A. 02004

Filter

Mixture

Total

After Extr.

Net.

Pass	1½	3.4	204
Pass	1¼	12.8	768
"	1	23.4	1404
"	¾	13.7	822
"	2	13.6	816
"	4	7.7	462
"	8	3.2	192

Spec. Grav. material used:

.778 × 2.84 = 2.210√

.222 × 2.75 = .610√

Spec. Grav. 2.820√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6418√
Weight of cone full of Min. Agg.	9635
Min. Agg.	5271
Voids	1147

17.87 V

" 10	5.0	300	%	"
" 20	2.9	174		
" 30	1.7	102		
" 40	1.0	60		
" 50	3.7	222		
" 80	1.6	96		
" 100	2.2	132		
" 200	4.1	246		
	100.0	6000		

Lab. No. P. A. 01879

Filter

Mixture

Total

After Extr.

Net.

Pass	1½		
Pass	1¼	7.3	438
"	1	13.8	828
"	¾	15.8	948
"	2	17.0	1020
"	4	10.0	600
"	8	3.4	204

Void Test

Spec. Grav. material used:

.673 × 2.84 = 1.911√

.327 × 2.75 = .899√

Spec. Grav. 2.810√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6395√
Weight of cone full of Min. Agg.	9727
Min. Agg.	5363
Voids	1032

" 10	9.5	570	%	"	$16.14\sqrt{}$
" 20	4.9	294			
" 30	2.7	162			
" 40	1.5	90			
" 50	3.8	228			
" 80	1.2	72			
" 100	3.3	198			
" 200	5.8	348			
	100.0	6000			

Lab. No. P. A. 01810
Filter
Mixture
Total
After Extr.

Net.			%	Grams.
	Pass	1½		
	Pass.	1¼	3.2	192
	"	1	8.6	516
	"	¾	22.0	1320
	"	2	22.8	1368
	"	4	9.0	540
	"	8	3.2	192

Void Test
Spec. Grav. material used:
.688 × 2.84 = 1.954√
.312 × 2.75 = .858√
Spec. Grav. 2.812√

Weight of cone	4364
" " " full water	6640
Capacity	2276
Contents if no voids	6400√
Weight of cone full of Min. Agg.	9775
Min. Agg.	5411
Voids	989

15.45 √

" 10	7.3	438	%	"
" 20	4.4	264		
" 30	2.6	156		
" 40	1.7	102		
" 50	4.5	270		
" 80	1.8	108		
" 100	4.2	252		
" 200	4.7	282		
	100.0	6000		

Lab. No. P. A. 01701
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½		
Pass	1¼	8.2	492
"	1	9.5	570
"	¾	15.7	942
"	2	19.2	1152
"	4	9.9	594
"	8	3.9	234
"	10	9.6	576

Void Test

Spec. Grav. material used:

.664 × 2.84 = 1.886√

.336 × 2.75 = .924√

Spec. grav. 2.810√

Weight of cone	4363
" " " full water	6639
Capacity	2276
Contents if no voids	6395√
Weight of cone full of Min. Agg.	9641
Min. Agg.	5278
Voids	1117
% "	17.46√

" 20	4.8	288
" 30	2.6	156
" 40	2.2	132
" 50	3.0	180
" 80	2.9	174
" 100	4.2	252
" 200	4.3	258
	100.0	6000

Void Test

Lab. No. P. A. 01587

Filter

Mixture

Total

Spec. Grav. material used:

.663 × 2.84 = 1.883√

.337 × 2.74 = .923√

Spec. Grav. 2.806√

After Extr.			%	Grams.		
Net.	Pass	1½	4.7	282	Weight of cone	4365
	Pass	1¼	0.0	00	" " " full water	6641
	"	1	3.8	228	Capacity	2276
	"	¾	13.4	804	Contents if no voids	6386√
	"	2	25.4	1524	Weight of cone full of Min. Agg.	9617
	"	4	13.5	810	Min. Agg.	5252
	"	8	5.5	330	Voids	1134

17.76√

" 10	9.6	576	% "
" 20	4.4	264	
" 30	2.0	120	
" 40	2.9	174	
" 50	3.8	228	
" 80	1.4	84	
" 100	4.2	252	
" 200	5.4	324	
	100.0	6000	

Lab. No. P. A. 01544
Filter
Mixture
Total
After Extr.
Net.

		%	Grams.
Pass	1½		
Pass	1¼	3.1	186
"	1	5.8	348
"	¾	16.3	978
"	2	26.5	1590
"	4	9.6	576
"	8	4.4	264

Void Test
Spec. Grav. material used:
.657 × 2.84 = 1.866√
.343 × 2.75 = .943√
Spec. Grav. 2.809√

Weight of cone	4365
" " " full water	6641
Capacity	2276
Contents if no voids	6393√
Weight of cone full of Min. Agg.	9700
Min. Agg.	5335
Voids	1058

" 10	7.7	462	%	"	16.55√
" 20	4.6	276			
" 30	2.7	162			
" 40	2.1	126			
" 50	4.8	288			
" 80	2.5	150			
" 100	4.8	288			
" 200	5.1	306			
	100.0	6000			

Analysis of
Lab. No. P. A. 01266
Filter
Mixture
Total
After Extr.

			%	Grams.
Net.	Pass	1½	4.6	276
	Pass	1¼	2.5	150
	"	1	12.6	756
	"	¾	22.0	1320
	"	2	24.7	1482
	"	4	7.1	426
	"	8	3.8	228

Void Test
Spec. Grav. material used:
.773 × 2.84 = 2.195√
.227 × 2.75 = .624√
Spec. Grav. 2.819√

Weight of cone	4365
" " " full water	6641
Capacity	2276
Contents if no voids	6416√
Weight of cone full of Min. Agg.	9560
Min. Agg.	5195
Voids	1221

" 10	6.2	372	% "	19.03√
" 20	3.3	198		
" 30	1.0	60		
" 40	2.4	144		
" 50	3.0	180		
" 80	1.3	78		
" 100	3.0	180		
" 200	2.5	150		
	100.0	6000		

% voids in Min. Agg.....19.03

Tests made to determine percentage of voids in mineral aggregate of P. A. 01266 which showed analysis given below and which was an uncompressed sample of bitulithic mixture taken from a load of same mixed at Oskar Huber's plant in Jackson Co., Ore., on Aug. 19, 1919, and laid at sta— on Green Springs Mountain Road—Calif. line section of Pac. Highway.

Plaintiff's Exhibit No. 21.

HERE IS THE REPORT.

Hon. C. C. Colt, President,
Portland Chamber of Commerce.

Your committee, to whom was referred for report and recommendation the public contracts which will be let relative to the bond issue recently passed for good roads, begs to report as follows:

TOOK STENOGRAPHIC NOTES.

Your committee first met on the 28th day of April and decided that it would be a wise procedure to institute a series of hearings at which stenographic notes be taken for the purpose of extending the same in transcript form for present and future reference. It was thought that in this way your committee would establish an orderly procedure for giving opportunity to anyone who might desire to present themselves and state their qualifications and views on the general subject of highway construction.

VISITED PAVEMENTS.

These hearings were supplemented by an investigation of pavements and highways within the city limits of Portland and contiguous thereto, as well as visits to chemical laboratories where pavements are subjected to various tests to ascertain whether they conform to established standards.

In this way your committee feels that it has approached and investigated the subject in as comprehensive a manner as the limited time placed at its disposal would permit. Attached to this

report and made a part hereof is a copy of the transcript of the testimony taken by your committee.

NO NEED TRAVEL FAR.

In it is personal inspection of pavements of the city of Portland and vicinity, your committee arrived at the conclusion that it was not necessary to visit any other community to ascertain the behavior of all forms of hard surface pavements under traffic conditions, for your committee was able to find in Portland and its vicinity all of the standard hard surface types of pavement being actually subjected to daily traffic and weather conditions.

There is this much to say with reference to the construction of permanent county roads as distinguished from city pavements—in county road construction opposite lines of travel are confined to a relative small area of surface. This is due to the fact that county road construction usually varies in width from 12 to 20 feet, as far as hard surfacing is concerned, while in city pavements opposite lines of travel are spread over a greater area, the width of hard surfaced streets being generally wider than country highways.

PROBLEM DIFFERS FROM CITY.

The result of this is that there is a concentration of the lines of travel upon a country highway that does not exist in city streets.

The next difference between country highways and city streets is this—that upon the question of

repair the problem is a different one with reference to the country road than to the city street.

LONG WAY FROM PLANT.

A country road is apt to be, on an average, a greater distance from the base of the supply of repairing material than is a city street. The result of this is that there is an increase of the unit cost of repair upon a country road over that of the city pavement.

TRAFFIC INTERRUPTIONS.

Another distinction is this—that in the repair of the hard surfaced city street, during the time of repair, traffic may be diverted to parallel streets within a short distance of the street to be repaired, which can, without any great inconvenience, reach the almost identical territory which is served by the street under repair, while on the country highway the interruption to traffic for the purpose of the repair is apt to inconvenience a territory that is not otherwise served.

TAKES LONGER TO CLEAN.

Another important factor in a comparative sense is the facility and opportunity for cleaning highways and city streets. With reference to the cleansing of the city street, cities usually maintain efficient cleaning departments with comparatively low cost, owing to a sufficient number of hard surfaced pavements, allowing cleaning to be done upon both the out-going and returning trip.

Ordinarily in the cleaning of a country road there is a large loss of time for the cleaning apparatus in returning from the end of the clean-

ing trip to the base of operation. This may be somewhat mitigated if country highways are constructed along the lines of complete out-going and returning circulation. However, it is not reasonable to expect that as efficient a country cleaning force can be maintained as is maintained in the city. It is neither desirable or necessary if the type of pavement is chosen for country highways whose life is not vitally dependent upon its being kept clean.

SHOWS BASIS COMPARISON.

The effect of the above distinctions is that with reference to country highways a city pavement, particularly in regard to its life and cost of maintenance, is not an absolute criterion for a country road type. It is a criterion, however, for the purpose of ascertaining the behavior of various types of pavement under weather and traffic conditions.

There is another distinction which might be made between a city pavement and a country road, and that is this—generally, adjacent to a roadway devoted to general vehicle traffic is a sidewalk for pedestrians, which is separated from the roadway area by a substantial curb, while the country roads have made a practice, from the standpoint of economy, of having the hard surface area of less width than the right of way of the road.

In such construction, ordinarily the roadway is not divided by a substantial curb, but there is a construction, a shoulder generally, of macadam which furnishes a width of road on which traffic

may pass or turn. The junction of the hard surfaced part of the road with the macadam next to it introduces a road problem that is not generally met in the city street.

NOT CUT UP SO OFTEN.

On the other hand, the most trying problems of the city pavement are not often met with in country road construction; they are the continually cutting in of the pavement of the city street for the purpose of getting at pipes and wires and the establishing in city streets of auxiliary furniture, generally in the way of catch basins and man-holes; and the laying of hard surfaced pavement adjacent to street railroad tracks.

It has been found that many city pavements that were otherwise good, have failed owing to these complications; therefore, the fact that a city pavement does not fail otherwise than above specified would seem to commend it for use upon country roads.

DISCUSSES LEGAL STATUS.

At this point it might be well to make reference to the principal sources of statutory law under which Multnomah County must look for the construction of its contemplated highway system under the $1,250,000 bond issue recently authorized.

The principal statute on the subject is Chapter 103 of the Laws of 1913, found on page 170 *et seq.* of the General Laws of Oregon for 1913. Under this law, after the fourth year until the maturity of the bonds, the law requires that a specified amount be set aside, the object being to retire the bonds

serially at the end of the 15 years the county will have retired its indebtedness created for road construction. It therefore seems advisable that the kind of pavement be selected which, with a reasonable amount expended for maintenance, will insure a condition of the road as good at the time the bonds are retired as it was at the date of construction.

MINIMUM, 15 YEARS LIFE.

In other words, it would be extremely poor public finance to have the road system in such a state of dis-repair prior to the time all bonds are retired, as to be, for all practical purposes, useless. Therefore, 15 years should be required as the minimum life of any road system constructed under the 15 year bond issue.

Returning again to Chapter 103 of the General Laws of 1913, your committee found that in a good many instances the law is somewhat indefinite, but as this developed points of construction applied to matters that occurred before the authorization of the bond issue by election, and are of an immaterial nature, your committee refrains from giving consideration to most of them.

At this stage of the road development, however, there are two sections of the law that should be discussed. They are Sections 13 and 24. Section 13 is as follows:

> "All monies raised under the provisions of this act shall be used in constructing permanent public roads in that county, which roads shall be constructed by the county court under its exclusive jurisdiction and such expert assistance

as they may employ." Section 24—"The County Court shall prepare plans and specifications of said road and shall invite bids in conformity to such plans and specifications, and may also receive and consider any and all bids in conformity to any plans and specifications furnished by any individual, firm or corporation offering to bid on such roads. The County Court shall have power to reject any and all bids."

In legal parlance it may be stated that these two sections of the road law become the subject of construction. This is true because there is a possibility of a conflict between the provisions of one, when considered with reference to the provisions of the other. A general rule of construction of statutory law requires that statutes, or sections of the same statute that seem to be in conflict should be reconciled if possible. That is to say that in this particular case, if the two sections are subject to a construction that makes one in conflict with the other, and also a construction that will reconcile one with the other, the rule is that the one that reconciles them is the governing rule of construction.

The possible conflict between Sections 13 and 24 is this—that if the sense of Section 13 be taken standing alone it would seem to indicate that the County Court is given authority under the law to purchase material and employ labor and expert assistance for the construction of county roads. While, if Section 24 is taken by itself, it would

seem to indicate that the authority of the County Court is limited to the preparation of plans and specifications and thereafter must receive bids for the construction of roads by contractors. However, if the general rule of law be followed, which your committee thinks of necessity must be the construction that could be placed upon these two sections is this—that in the first instance the County Court must cause plans and specifications to be prepared.

In the preparation of this work, under Section 13, it would have authority to employ expert assistance; that the plans and specifications must be published and bids received. The right is reserved, however, to the County Court to reject any and all bids. If it accepts a bid, then, under Section 13, it would have authority to employ such expert assistance in the way of inspection and otherwise as would insure a proper conformity by the contractor of his contract.

But Section 24 must be given consideration over and above its possible construction with Section 13, and that is this—under Section 24 the County Court does not seem to be under the necessity to make its award to the lowest responsible bidder bidding on the same type of pavement. Authority under this section is also given to the County Court to reject all bids. The law however—that is, Chapter 103—is silent as to what procedure the County Court may follow in case all bids are rejected. The law seems neither to contemplate that the County Court may re-advertise for bids

or to proceed to construct the road by the purchase of material and the employment of labor.

This being so, your committee is of the opinion that the law with reference to this subject must be found elsewhere, possibly among the general statutes of the state with reference to the power and jurisdiction of the County Court to construct roads. Further, the statute being silent as to what procedure may be followed in case all bids are rejected, your committee is of the opinion that Section 25 of Chapter 103 would not act as a repealing clause against any general road statute which dealt with the special matter of the power of the county with reference to roads in a case where all bids were rejected. Your committee has not had time to investigate the general road statutes with reference to this subject, but in its investigations it was brought out by Mr. E. E. Coovert, an expert lawyer on the subject of road law, that in his opinion in many particulars the general road law and other statutes should be construed as supplementing Chapter 103 of the laws of 1913.

BUILD BY DAY LABOR.

A proposition has been brought to the attention of your committee by Messrs. McMullen and Dulin that they stand ready to enter into a contract with the county by which the county is to construct the contemplated road system by the purchase of material and the employment of labor.

LABOR COUNCIL SUPPORTS PLAN.

These gentlemen have submitted a proposition to the county under the date of April 21st, 1915, sup-

plemented by a further communication, copies of which are hereto attached and for better reference are marked Exhibit A.

Their plan is that the county establish a paving plant at Kelly Butte and control the mixing and laying of the pavement, the county to pay all expenses of running the plant and labor incident to the mixing and laying, these gentlemen to act as expert assistants to the county for which they would receive a compensation of $200 per month.

CLAIM 60¢ COST.

It is their claim that they can lay types of bituminous pavement at a cost to the county of less than 60 cents per square yard, not taking into consideration the cost of royalty if the county decides to hard surface the system of county roads or any portion thereof by using a patent pavement. That, in addition to their compensation of $200 per month each for their services, they receive a bonus equal to thirty-three and a third (33⅓) per cent of the amount saved by laying such pavement at less than 60 cents per yard; their proposition providing that none of this bonus shall be paid to them at the completion of the pavement but shall remain in trust for five years.

IS INGENIOUS PROPOSAL.

If, during that period, any defects appear in the pavement as laid there shall be deducted from the bonus an amount sufficient to defray all expenses of repairing pavement, and only the amount

remaining in the bonus after repairs have been made shall be paid to them.

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This presents an interesting proposition.

ARE CHEMICAL EXPERTS

Your committee held conference with Messrs. McMullen and Dulin and visited the paving testing laboratory of the city of Portland where these gentlemen are at the present time employed.

HONEST AND SINCERE.

All the members of your committee became profoundly impressed with the knowledge that these gentlemen possess with reference to the physical and chemical properties of pavements.

Your committee was further impressed with the honesty and sincerity of these gentlemen.

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Incidentally, throughout these hearings paving contractors were interrogated with reference to the cost items presented in the communications of Messrs. McMullen and Dulin.

FIGURES SEEM TOO LOW.

Where these interrogations were made the answers were that the figures of Messrs. McMullen and Dulin were too low; that they had failed to take into consideration certain overhead and depreciation expenses.

Undoubtedly, in a measure, this criticism is correct, but our investigations also led us to the conclusion that certain items which contractors habitually include as cost items, while legitimate in the general paving business, would not and should not be considered if the county were to employ

labor, purchase material and directly construct the road system.

These items principally concern themselves with what might generally be called items of sales expense. A contractor or a paving company must of necessity be brought in competition with other types of pavement, and in order to get the business an efficient and intelligent sales department must be maintained.

This is usually a high salaried department, because it requires exceedingly clever men—men convincing, persuasive, honest and possessing a profound knowledge of the details of the paving business. This, we say, would not apply to the county after it once settles the type of pavement that it desires to construct. There is an element, however, that enters into the cost items of construction possibly not contemplated by Messrs. McMullen and Dulin, and that is this:

That the success of most types of pavement depends upon the skill and accuracy in preparing the preparation and laying it upon the roadbed.

COST OF MAINTAINING ORGANIZATION.

That in order to command the services of the best skill in this respect it is necessary to carry on the payrolls of whoever is constructing a pavement these skilled employees over a period of time when seasonal conditions prevent paving construction.

It goes without saying, of course, that if the county were to enter into general hard surface road construction it would eliminate contractors'

profits in road construction. The county, however, as well as any contractor, would have to meet royalty payments if it decided to use a patent pavement, assuming, of course, that the patent to the pavement is sustainable.

DANGER POLITICAL INTERFERENCE.

As against this item of the contractor's profit, however, is the danger of political interference in road construction by the county. Your committee does not wish to be understood to imply or intimate that there is political influence existing at the present time with reference to the road system of the county as administered by the Board of County Commissioners. In fact, your committee knows of no such influence, and does not wish to infer that any exists. But, it does say that this danger is one that has arisen where construction is done directly by public authority, and, therefore, the danger might confront us in the future.

NOT FREE FROM DOUBT.

It is the understanding of your committee that the Board of County Commissioners has rejected the proposition of Messrs. McMullen and Dulin. Your committee also desires to state that their proposition is not free from doubt as a legal question. Your committee will not and does not say that their proposition could be accepted by the county as a matter of law or that it could not be accepted as a matter of law.

PORTABLE PLANT SUGGESTED.

Objection has been urged to their proposition on the ground that a $50,000 plant at Kelly Butte could not furnish the facility for material for the contemplated road construction on two grounds—first, that the material could not be turned out fast enough; second, that in order to economically construct all the portions of the road system portable plants must be established to furnish a near base of supply.

To this Messrs. McMullen and Dulin answer that at a very low cost the county could establish the portable plants suggested. It is also urged that, without an undue expenditure of money for equipment, the county would be unable to hard surface the road system contemplated within a reasonable length of time; while under the contract system, if work were let to a responsible contractor, he could bring to bear upon the work sufficient equipment to rapidly perform the work, due to the fact that his plant has already been assembled in his contracting business and after the completion of the contract he would have reasonable prospect of employing his plant in his general business.

COUNTY PLANT IDLE.

While in the plant of the county, unless the county were to continue in blocks of work equal to or nearly equal to the present block of hard surface construction—in other words, inasmuch as probably during the first five years of the pavement the repairs would be slight, there would be little use for large equipment; much of the equip-

ment would be idle unless the electors of the county authorized large future bond issues, and it is undoubtedly true, considering the problematical utility of a large county equipment, that the county would have to carry a disproportionate depreciation account on its plants, both fixed and portable.

There is some tendency for cities and counties to maintain their own paving plants. It may be said, however, that this question is one on which, as a policy, there is a considerable divergence of opinion. In a measure Multnomah County now maintains such a system with reference to the macadamizing of the present county roads, and we understand that Pierce County, Wash., partially maintains such a system, or has done so while constructing its cement roads, in order that its roads may be supplied with properly selected and washed sand, gravel and broken stone.

QUESTION OF PUBLIC POLICY.

In conclusion, on this point your committee is of the opinion that the items of road cost do not lie entirely in Messrs. McMullen's and Dulin's figures, nor do they lie entirely with the cost items of contractors. They seem to repose somewhere as a middle ground between the two, and your committee feels that the general membership of the Chamber or its Board of Directors is fully capable of deciding for itself whether the work shall be done under the contract system or under direct construction by the county; for, after all,

it is a question of policy upon which public and individual opinion is divided.

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WHAT ARE FUNDAMENTAL REQUIREMENTS?

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Your committee now comes to the point in its report in which it approaches the question of desirability of pavement.

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In order that pavements may be classified, an outline of just what requirements a pavement should conform to seems desirable. After this has been ascertained, the prevailing types of hard surface pavements should be subjected to an analysis in order that it may be ascertained which of the pavements contains most of the elements of desirability. The best discussion of the subject under present consideration that your committee has been able to find appears in "Bryne on Highway Construction," the fifth and latest edition, which was issued in 1913. We have found the discussion of this author so good that we must be pardoned for quoting rather heavily from his opinions. On page 1 he says:

> THESE QUALITIES ESSENTIAL.
>
> The qualities essential to a good pavement may be stated as follows:
>
> No. 1—It should be impervious.
>
> No. 2—It should afford good foothold for horses.
>
> No. 3—It should be hard and durable, so as to resist wear and disintegration.

No. 4—It should be adapted to every grade.

No. 5—It should suit every class of traffic.

No. 6—It should offer the minimum resistance to traffic.

No. 7—It should be noiseless.

No. 8—It should yield neither dust nor mud.

No. 9—It should be easily cleaned.

No. 10—It should be cheap.

Continuing, he says:

Of the above requirements No. 2, 4, 5 and 6 affect traffic and determine the cost of haulage by the limitation of loads, speed, wear and tear of horses and vehicles.

If the surface is rough or the foothold bad the weight of the load a horse can draw is decreased, thus necessitating the making of more trips or the employment of more horses and vehicles to move a given weight.

A defective surface necessitates a reduction in the speed of movement and consequent loss of time.

It measures the wear on horses, thus decreasing their life service and lessens the value of their current services.

It also increases the cost of maintaining vehicles and harness.

No. 7, 8, and 9 affect the occupiers of the adjacent premises, who suffer from the effect of dust and noise; and second, the owners of said premises whose incomes from rents is diminished when these disadvantages exist.

No. 3 and 10 affect the taxpayers alone; first as to length of time during which the covering

remains serviceable and second as to the amount of annual repairs.

No. 1 affects the adjacent occupiers principally on hygienic grounds.

No. 7 and 8 affect both traffic and occupier.

MOTORS NEW PROBLEM.

With reference to present traffic conditions and their application to county roads, the above essential qualifications of Bryne need modification. At the present time the large volume of traffic is moved by motor vehicles and this introduces a new traffic problem of its own, and minimizes the traffic problems of horse drawn vehicles.

MUST NOT IGNORE HORSES.

But, while this is so, horse traffic must not and cannot be ignored on county roads. The quality of a pavement being noiseless is not as necessary on a county road as on a city street, and its ease of being cleaned, except where dirt affects the life of the pavement, is not so important a country as a city problem, altho it cannot be entirely ignored in country construction. The element of cost is a more vital problem in the country road than in the city street, owing to the fact that in city streets the original cost of construction is usually charged to abutting property, and the improvement by hard surfacing and adjacent street represents a greater percentage of increased value to abutting property.

ELEMENT OF COST VITAL.

There is a tendency for city property to sell

more rapidly in small lots than there is for country property to so sell, and the street assessment represents a smaller element measured against property value in the city than the country. The result is that the city owner can more readily transfer the cost of the hard surfaced pavement assessed to abutting property while the country land owner cannot.

This applies more particularly where a country road is constructed under an assessment against abutting property; but, nevertheless, even where the county constructs directly it has an indirect bearing, inasmuch as the general tax is a more distasteful tax than an assessment for special benefits. Therefore, country road construction consistent with durability should be a cheaper pavement than a city pavement.

COMPARES COST OF HAULING.

On page 3 of the above cited authority is given a table which sets out the cost of transportation by horse and wagons per ton mile on different road coverings. The table is as follows:

Transportation on iron rails	1.28¢
On asphalt	2.70¢
On stone paving, dry and in good order	5.33¢
On stone paving, dry and in ordinary condition	.12¢
On stone paving, covered with mud	21.30¢
On earth, dry and hard	18.
On earth, full of ruts and mud	39.
On loose gravel	51.60¢
On gravel, compact	12.80¢

On plank in good condition..... 8.80¢
On sand, wet..... 32.60¢
On sand, dry..... 64.

On page 4 the author says:

> The problem involved in the selection of the most suitable pavement is composed of the following factors—first, adaptability; second, desirability; third, serviceability; fourth, durability; fifth, cost.

MUST FIT LOCAL USE.

Adaptability: Continuing the author says:

> The best pavement for any given roadway will depend altogether on local circumstances.
>
> Pavements must be adapted to the class of traffic that will use them. The pavement suitable for a road thru an agricultural district will not be suitable for the streets of a manufacturing center, nor will the covering suitable for heavy traffic be suitable for a pleasure drive or residential district.

MUST SATISFY USERS.

Desirability: With reference to this, he says:

> The desirability of a pavement is its possession of qualities which make it satisfactory to the people using and seeking it. Between two pavements alike in cost and in durability, people will have preferences arising from the condition of their health, personal prejudices, and various other intangible influences, causing them to select one rather than the other.
>
> The economic desirability of pavements is governed by the ease of movement over them,

and is measured by the number of horses or pounds of tractive force required to move a given weight, usually one ton, over them.

COMPARES HORSE EFFORT.

The author then gives a table for level roads, surface of which is formed of different materials, in which he takes asphalt as the standard of excellence. By this table he shows the number of horses required to move one ton over these different pavements. The table is as follows:

Asphalt	1.00
Stone blocks dry and in good condition	1.50 to 2.00
Stone blocks in fair condition	2.00 to 2.50
Stone blocks covered with mud	2.00 to 2.70
Macadam, dry and in good condition	2.50 to 3.00
Macadam, in a wet state	3.30
Macadam, in fair order	4.50
Macadam, covered with mud	5.50
Macadam, with stones loose	5.00 to 8.20

SMOOTHNESS IS ECONOMY.

From the above table the great economy of smoothness becomes at once apparent. But it is evident that, as in all lines of transportation, the greatest resistance regulates the load over the rest of the route, unless there be auxiliary power; so the continuity of the surface should remain unbroken by any other grade of material which would increase the resistance.

EXPENSE CAUSED TO TRAFFIC.

The author discusses serviceability as follows:

The serviceability of a pavement is its quality

of fitness for use. This quality is measured by the expense caused to the traffic using it.....No statistics are available from which to deduct the actual cost of wear and tear. It has been estimated as follows:

	Per Mile of Travel.
On cobblestones	5¢
Belgian blocks	4¢
Wood	2.5¢
Broken stone in first class condition	1.2¢
Asphalt	1¢

FOOTHOLD FOR HORSES.

The serviceability of any pavement depends in a great measure upon the amount of foothold afforded by it to the horses, provided, however, that its surface be not so rough as to absorb too large a percentage of the tractive energy required to move a given load over it. Cobblestones afford excellent foothold but the resistance to motion requires the expenditure of about 280 pounds of tractive energy to move a load of one ton. Asphalt affords the least foothold but the tractive force required to overcome the resistance it offers to motion is only about 30 pounds per ton.

WHEN HORSES FALL.

Comparative safety. The comparison of pavements in this respect is the distance traveled before a horse falls. The materials affording the best foothold for horses are as follows, stated in the order of their merit.

1. Earth dry and compact.
2. Gravel.
3. Macadam.
4. Wood.
5. Sandstone and brick.
6. Asphalt.

*7. Granite blocks.

HOW FAR HORSE WILL TRAVEL.

The author then gives a table showing how far a horse will travel over the various pavements, which was worked out by Capt. F. B. Greene, and it is as follows:

Asphalt	583 miles
Granite	413 miles
Wood	272 miles

HAYWOOD FAVORS WOOD.

For the same purpose observations were made in London by Col. Haywood. He compared wood, asphalt and stone under conditions as nearly identical as possible. The observation was for fifty days, and it showed that before meeting with an accident a horse would travel a greater distance on wood than he could either on asphalt or stone. Col. Haywood's table is as follows:

WEATHER AFFECTS HORSE SAFETY.

Dry Weather Distances.

Wood	646 miles
Asphalt	223 miles
Granite	78 miles

*Note—Committee's explanation, not given by author, this would include Belgian blocks.

Damp Weather Distances.

Wood	193 miles
Asphalt	125 miles
Granite	168 miles

Thoroughly Wet Weather.

Wood	432 miles
Asphalt	192 miles
Granite	537 miles

Under another mode of observation the distance may be given as follows:

Wood	446 miles
Asphalt	191 miles
Granite	132 miles

COMPARES SLIPPERYNESS.

It thus appears, from the above tables, that asphalt is the most slippery when damp and safest when perfectly dry; granite slippery when dry and safest when wet; wood most slippery when damp, safest when dry.

STONE BLOCKS SAFEST.

When climatic conditions of Western Oregon are considered, granite or Belgian blocks being slippery when perfectly dry but safe when perfectly wet, stone blocks must be considered the safest pavement, and that as between asphalt and wood, wood is the safest. Granite seems to be least safe when clean and wood and asphalt most safe when clean. Slight rains make asphalt and wood more slippery than they do at other times. Asphalt becomes slippery almost at once after a slight rain, while wood requires more rain, before it

reaches its worst condition, but slipperiness lasts longer on wood.

It will be noted in the above that the tables of Greene and Haywood differ, Greene's table having been taken in the eastern cities of America and Haywood's with reference to the London pavements. Probably climatic conditions explain the difference in the two tables.

HOW TO OVERCOME.

There is also another explanation for the behavior of asphalt, and that is that the asphalt as laid in Europe is a more slippery pavement, owing to the methods of its construction, than the asphalt laid in the United States. The authorities seem to agree that slipperiness can be cured in asphalt by the spreading of sand, and on wood block pavements by the spreading of pea gravel and the rolling of the same over the surface by a steam roller.

DIFFERENCE IN FALLS.

On page 21 of his work on Highway Construction, Bryne discusses the character of falls on various pavements as follows:

> The commonest falls on wood are falls on the knees, which are less likely to injure the horses and are less inconvenient to traffic than other falls. Falls on haunches are more numerous on asphalt than on wood. Complete falls are fewest on wood and most on granite. The falls on asphalt are generally due to sudden pulling up and short turning; those on granite,

to excessive width of the blocks, which fail to afford proper foothold.

MAKES DIFFERENCE IN DURABILITY.

On page 10 the author discusses the durability of the pavement and says:

> The durability of the pavement is its quality which relates to the length of time during which it is serviceable, and not the length of time it has been down. The only measure of the durability of a pavement is the amount of traffic tonnage it will bear before it becomes so worn that the cost of replacing it is less than the expense incurred by its use.

LENGTH OF PAVEMENT LIFE.

On page 11 he says:

The life or durability of the different pavements under like conditions of traffic and maintenance may be taken as follows:

Granite Blocks	12 to 30 years
Sandstone	6 to 12 years
Asphalt	10 to 14 years
Wood	3 to 7 years
Limestone	1 to 3 years
Brick	5 to 12 years

With reference to this table it may be stated that no reference is made to Belgian blocks. They should be properly classified, in our judgment, with granite blocks. No reference is made to asphaltic concrete, which, in our judgment, should occupy a position between Belgian blocks and asphalt, possessing a higher degree of merit than asphalt.

In the reference to the classification of wood the author fails to state whether the wood has been preserved by creosote or otherwise. We are inclined to the opinion that, if wood blocks are properly treated with a preservative, they would take a higher classification than that given in the table. The author also further fails to state whether the paving bricks were vitrified. We are inclined to the oppinion that vitrified bricks should take a better classification than given by the author.

WHY COST VARIES.

Continuing on page 13, the author says:

> The cost of construction is largely controlled by the locality of the place, its proximity to the particular material used and character of the foundation.

On page 14 he says:

> The first cost of pavement is like any other permanent investment, measurable for purposes of comparison by the amount of annual interest on the sum expended.

DISPELS POPULAR ERROR.

> *Maintenance.* Under this head must be included all outlays for repairs and renewals which are made from time to time when the pavement is new and at its best to a time subsequent, when by any treatment it is again put in equally good condition.

The prevailing opinion that no pavement is a good one unless, when once laid, it will take care of itself is erroneous; there is no such pavement.

ATTENTION! SAYS COMMITTEE.

At this point your committee wants to, with great emphasis, call attention to the above statement. Your committee is of the opinion that the greatest problem in permanent road construction is the wearing surface. Your committee is of the opinion that the wearing surface of any road has a comparatively short life. This being so, your committee regards the real vital problem in road construction as the maintenance problem. As verification of this point, your committee will continue the quotation of Bryne. He says:

MAINTENANCE THE VITAL PROBLEM.

All pavements are being constantly worn by traffic and the action of the atmosphere, and if any defects which appear are not quickly repaired they soon become unsatisfactory and are destroyed. To keep them in repair incessant attention is necessary and is consistent with economy. Yet claims are made that particular pavements cost little or nothing for repairs, simply because repairs are not made, while anyone can see the need of them.

Bryne gives a table showing the comparative cost of various pavements in Liverpool, including interest on first cost, sinking fund, maintenance and cleaning, when reduced to a uniform traffic of 100,000 tons per annum for each yard in width of the carriage way. It follows at top of next page:

SHOWS COST PER YEAR FOR LAST FIFTY YEARS.

Bryne's Table Includes Interest, Repairs, Maintenance, Replacement and All Other Expense, Based on Experience of Half a Century in United States.

	Granite Blocks	Asphalt	Wood	Brick
Foundation	$ 1.00	$ 1.00	$ 1.00	$ 1.00
Material, labor, etc.	3.25	2.50	1.40	1.80
Total first cost	$ 4.25	$ 3.50	$ 2.40	$ 2.80
Interest on material, and sinking fund, 50 years, 4%	26.00	20.00	11.20	14.40
Interest on foundation	2.00	2.00	2.00	2.00
Maintenance 50 years	2.50	4.50	7.50	2.50
Cleaning 50 years	5.00	1.00	6.00	2.50
Three renewals of surface at $3.25	9.75	....	....	....

	Granite Blocks	Asphalt	Wood	Brick
Five renewals at $2.50	....	12.50	....	....
Twelve renewals at $1.40	....	....	16.80	....
Eight renewals at $1.80	....	....	....	14.40
Consequential damages	10.00	1.00	1.50	2.00
Cost of service estimated	30.00	10.00	20.00	15.00
Total	$89.50	$54.50	$67.40	$55.60
Less value of foundation	1.00	1.00	1.00	1.00
	$88.50	$53.50	$66.40	$54.60
Less value of old material	1.00	.10	.00	.25
	$87.50	$53.40	$66.40	$54.35

Which, divided by 50, that being the life of the pavement in years, gives the annual gross cost per square yard per annum as follows:

Granite blocks	$1.75
Asphalt	1.068
Wood	1.33
Brick	1.087

	Per sq. yd. per annum
Block pavements of hard granite	23c
Block pavements of soft granite	28c
Bituminous concrete	35¢
Wood pavement	53c
Macadam on pitch foundation	71c

When the traffic is taken at 40,000 tons per annum for each yard, the showing is as follows:

Bituminous concrete	27c
Wood	41c
Macadam	47c

Asphalt is not given in this table, neither are Belgian blocks or vitrified brick, and it is not stated whether the wood was treated with a preservative.

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Bryne places asphalt between wood and bituminous concrete, making it better than wood but inferior to bituminous concrete.

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On page 209 is Bryne's table showing the approximate comparative gross cost of various pavements in the United States for a period of 50 years, the pavement at the end of that period to be in as good condition as when first laid, cost being per square yard.

CLASSIFIES "ASPHALTIC CONCRETE."

It will be noted that in this table asphaltic concrete is not given. Neither are Belgian blocks. In the opinion of your committee asphaltic concrete should take as good, or better, a classification as does sheet asphalt, and Belgian blocks will take the classification of granite blocks. The table fails to state whether the bricks are vitrified. If they are, they should take a classification more nearly approaching granite blocks. The table fails to state whether the wood has been subjected to preservatives.

TREATED WOOD BLOCKS.

We think that treated wood blocks should take a better classification that than which appears in the table. It will be noted that the items of consequential damages and cost of service are particularly severe on granite blocks and brick and are comparatively light on asphalt and wood. These items are of an intangible nature and any items of expenditure arising under them are more properly chargeable to the users of a highway than to a county laying a system of permanent roads.

CHARGE TO USERS, NOT COUNTY.

They are elements which your committee thinks in considering the sole question of ultimate cost to the county in laying a pavement should be eliminated and their elimination would materially alter the classification given to each pavement. The table is of value and interest, however, and all elements entering into the life of the pavement are to be taken into consideration. In conclusion, the rank

of pavements as to all of the elements above discussed may be classified as follows:

Durability.

1st ..... Granite
2d ..... Vitrified brick
3d ..... Asphaltic concrete
4th ..... Asphalt and wood

Serviceability.

1st ..... Asphaltic concrete
2d ..... Asphalt
3d ..... Wood
4th ..... Vitrified brick
5th ..... Granite blocks

Hygienic Fitness.

1st ..... Asphalt
2d ..... Asphaltic concrete
3d ..... Brick
4th ..... Granite blocks
5th ..... Wood

Service on Grades.

1st ..... Granite or Belgian block
2d ..... Brick
3d ..... Wood
4th ..... Asphaltic concrete
5th ..... Asphalt

Gross Annual Cost.

1st ..... Asphaltic concrete
2d ..... Asphalt
3d ..... Brick
4th ..... Wood
5th ..... Granite and Belgian block

However, as before explained, brick and Belgian block if all intangible elements are eliminated should take a better classification.

Facility for Cleansing.

1st ..... Asphalt
2d ..... Asphaltic concrete
3d ..... Brick
4th ..... Granite or Belgian block
5th ..... Wood

In the opinion of your committee this is not so important on a country road as on a city street.

AGENCIES OF DESTRUCTION.

Under this head, on page 24, Bryne says:

> The agencies causing destruction of paving materials may be classified as mechanical, chemical and physical and organic. It is estimated that the mechanical agencies cause 80 per cent of the destruction and the others 20 per cent. The mechanical and physical agencies exert the greatest action on the surface, while the chemical affects both the surface and the substratal portions.
>
> The mechanical agencies due to traffic are *(a)* Impact produced by the action of horses feet. *(b)* The precussive and abrading action of moving wheels. *(c)* The crushing due to the weight of the load on the wheels.
>
> The mechanical agencies are generally applied in their most destructive forms, namely, in the presence of water, this producing abtrition in the presence of a solvent, in which condition their destroying effect is most energetic.

The chemical agencies are water and the various acids present in the atmosphere, and the humus acids derived from the decomposition of animal and vegetable matter. The action of the chemical agencies is very slow, and their effect may be ignored except in the case of rock already in a state of decomposition or containing readily soluble mineral matter. The rocks that are most susceptible to the solvent action of water impregnated with acids are the limestone, calcareous sandstone and granite containing feldspar.

The physical agencies are:

(a) Air in the form of wind.

(b) Heat due to changes of atmosphere, and

(c) Ice.

Air acts mechanically to remove the loose material and transport it in the form of dust. Heat, through changes of atmosphere, causes expansions and contractions which produce a slight movement among the component particles of material, thus breaking their cohesion and leaving them more susceptible to the destroying effect of the other agents. Ice water penetrates into all the materials employed for paving purposes, and at the freezing temperature it acts mechanically to disrupt the material by the pressure exerted while passing from the liquid to the solid state.

Organic agencies. The organic agencies are vegetable or fungus growths that thrive in damp shady places.

Continuing on page 26, he says:

> The properties which the material used for paving must possess in order to resist the destroying agencies are physical and chemical. The physical properties comprise resistance to crushing, impact and abrasion. The chemical properties consists of the ability to resist, for a considerable length of time, the disintegrating action of the several physical, chemical and organic agencies due to weather and present on the surface of the roadway. This quality is generally designated by the term durability.
>
> The ability to resist crushing varies with the character of material and frequently varies to a considerable extent in the same material. In the plastic or viscous materials it depends upon the strength of the cementing medium or adhesive power of the matrix; in stones, brick, etc., it depends upon the cohesion and interlocking of the component particles.
>
> Since the resistance to crushing possessed by all the material commonly regarded as suitable for paving is in excess of that actually required in use, this property is of secondary importance in determining the enduring quality of material, especially when it is to be placed upon a good foundation. With a weak foundation high resistance to crushing and cross breaking is essential.
>
> Resistance to impact and abrasion. This property depends upon hardness and toughness of the material. These two properties, while

closely related, are not always coincident; some materials, although extremely hard are yet so brittle that they crush easily under pressure. Materials possessing extreme hardness polish readily under friction and produce a slippery and dangerous road surface.

Hardness is generally defined as that property of a solid which renders it difficult to replace its parts among themselves. When applied to the materials used for paving it signifies the resistance offered by the material to wear by abrasion under the action of wheels.

Toughness, as applied to paving material, may be defined as that property which enables it to resist fracture under the blows produced by traffic.

Durability depends upon the hardness, toughness and chemical stability of the material. Physical defects and abrasion generally cause the destruction of the material long before it is injured by chemical changes.

DEDUCTS IMPORTANT CONCLUSIONS.

From the above the following conclusions may be deducted:

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That any pavement that is weak in resisting mechanical and physical destruction is not a desirable pavement.

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Any pavement that is durable against destructive agencies which are mechanical and physical but is weak in its resistance to chemical agencies is the

most desirable pavement, provided that its chemical resistance exceeds in life the period of time that the best pavement, showing failure from mechanical and physical causes, possesses.

CHEMICAL ACTION MAIN TROUBLE.

As a general rule it may be stated that any pavement which is protected against mechanical destruction must be one which depends for its resistance to mechanical destruction upon chemical affinity. This chemical affinity employed to resist mechanical destruction generally takes the form of a cement principle and is often in those pavements having a sheet surface.

ADVANTAGE OF SHEET SURFACE.

The advantage of the sheet surface, as long as it maintains its chemical vitality, is that traffic is borne upon its surface in the form of compression rather than in the form of tension or shear.

However, sheet pavements must be distinguished in their resistance to tension and shear, with reference to the manner in which the blows and shocks of traffic are received by the sheet pavement.

With reference to this principle, sheet pavements are of two kinds:

(1) Those that resist blows and shocks of traffic under the principle of resiliency, and,

(2) Those which receive the same under the principle of rigidity.

In those receiving shocks by resiliency there is very little abrasion, while those that receive them rigidly are subject to abrasions. The principle of resiliency is found in sheet asphalt pavements and

in asphaltic concrete. The principle has been likened to successive poundings or blows upon lead; subjected to such force the lead shows but slight abrasion, but it thins out.

This is not the entire principal of the sheet asphalt or the asphaltic concrete pavements, however, inasmuch as after blows lead retains the new position that it assumed under the blows, while sheet asphalt and asphaltic concrete pavements conform to the principle of elasticity, and after cessation of traffic blows, develop the character to return to their former position.

LIKE BREAD DOUGH.

The kneading of bread dough is a fair illustration of the principle.

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But when shear of traffic destruction is considered, all sheet pavements, if they maintain the consistency that they assume at the time of completion, effectively resist the shear force, and it is only when under either physical force or chemical disintegration they lose their sheet-like surface, that they rapidly break down under the destruction of traffic.

DEFINES BLOCK PAVEMENTS.

Pavements that do not possess a sheet surface may be designated as block pavements.

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These are found in granite or stone blocks, brick, wood, concrete blocks and asphaltum molded or compressed blocks. The use of block pavements results in either one or two things. There will

either be two materials presented to surface wear, or if traffic is borne upon the block surface entirely there must be crevices between the various blocks.

Either one of these surfaces resulting in the employment of auxiliary material is due to the interlocking principle of the block pavement.

Block pavements, being composed of small units, require a grouting principle to maintain their position under traffic conditions. If the grout is brought flush with the surface of the block, two materials come in contact with traffic—the surface of the block and the surface of the grouting material. The result of this is, especially with reference to stone blocks and brick, that both the face of the block and the face of the grouting material is subjected to mechanical and physical destruction.

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Ordinarily the block is both hard and tough; that is, it is highly resistant to chemical disintegration, while if the grouting material is of a pitch, tar or bituminous nature, it is apt to be subject to chemical disintegration. If the grouting material is cement it results in the employment of a material that is rigid.

In stone block pavements the blocks are apt to become smooth, which is the result of abrasion, and the grouting material is apt to disintegrate chemically.

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The pavement, or any pavement in fact, is no stronger than its weakest part.

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If the block surface becomes smooth it becomes an undesirable pavement. If the grouting material disintegrates it becomes displaced and the block has a tendency to shift under traffic conditions. If the cementing principle is not brought flush with the top of the surface of the pavement, the corners of the block pavement are exposed to shear and tension. The result is that there is danger of chipping under these forces.

THEY LIVE LONG.

However, the history of stone block pavements and vitrified brick pavements is that they present a long life of durability. They are admirably suited for grades upon roads. In regard to block pavement the tendency of modern practice seems to be to make the blocks of smaller dimensions than formerly and to grout with tar or asphaltum in preference to concrete or cement. The principal objection to stone block pavements and vitrified brick pavements is their original cost. However, where grade conditions and heavy traffic conditions are of paramount importance their employment is of the highest necessity and the increase in cost justified.

WOOD FAVORED BACK EAST.

In regard to the wood block pavement as laid in Europe and in eastern cities of the United States, it has developed remarkable durability as to wear under heavy traffic conditions. Its principle fault lies in its tendency to swell and rot. Both of these

tendencies have been controlled by the use of preservative forced into the wood under pressure, principally creosote or carbolineum.

NEVER TESTED FAIRLY HERE.

Wood block pavements, in the opinion of your committee, have never been given a fair test in Portland.

However, there are samples of wood block pavements which have given splendid service in the city of Portland. There is a wood block pavement on Yamhill Street which was accepted by the city on the 23d day of August, 1903, and is still in fair condition. The wood pavement on the south portion of Fourth Street was laid in 1903 and taken up, as we recall, in the fall of 1913. It was subject to some swelling, but gave excellent results.

WHY FAILED IN PORTLAND.

In our opinion the wood blocks that have been laid in Portland have failed principally for the following reasons:

1st. They were laid upon a cushion of sand which is not good practice;

2d. The wood blocks were not properly selected as to the closeness of their grain and defects existing in the material;

3d. Expansion joints were absolutely disregarded;

4th. Sufficient attention was not given to the entire removal of sap;

5th. They were not properly impregnated with the preserving materials.

Wood blocks have given excellent service in Europe. The type of wood principally employed in Europe has been gumwood and Baltic fir, while the principal kind of wood used in the United States has been long leaf yellow pine, tamarack and gumwood. The pavements in the city of Portland have been composed, as we understand it, of Douglas fir.

FIR COMPARES FAVORABLY.

From the behavement of the Fourth Street and Yamhill Street pavement we think that Douglas fir compares favorably with any material that has been employed in the wood block pavement. The authorities seem to be pretty well agreed that soft woods are more preferable in the block pavement than are hard woods.

COSTS MORE AT FIRST.

It has been found, however, that a good wood block pavement, laid under careful supervision and correct specifications, is a pavement more expensive in first cost than pavements having the sheet-like principle. Our recommendation on wood block pavements is reserved for later discussion in this report.

CONCRETE CHEAPEST AT FIRST.

We now pass to the construction of the sheet pavements. Of these pavements the cheapest in first cost is the concrete pavement. This pavement is laid in what is known as 1 course or 2 course, and it ranges in price from about $1.00 per square yard to $1.37, unless a reinforcing principle is employed, when the cost is so materially increased as to place

it in the same category with other sheet pavements, and if the thickness of the material is increased in addition to the reinforcing principle, the cost approaches some of the cheaper grades of other block paving.

GETS FULL FORCE OF SHOCK.

As has been said heretofore in this report, a concrete pavement is a rigid pavement. It therefore, receives the full force of traffic shock. It is particularly susceptible to physical forces. This susceptibility is caused by its tendency to expand and contract, principally to contract. The result is that at an early period of its life it develops cracks. These cracks are not considered, by the authorities, as a vital defect in a concrete pavement. It does necessitate, however, an immediate repair of the crack, and if not repaired in a short time, the pavement having departed from its sheet principle and presenting an edge, develops a weak point which at once becomes subjected to the tension and shear of traffic. The result is concrete being weak in its resistance to these forces, the cohesion of the mass is broken down and the pavement begins to ravel.

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It is generally conceded that the cracking of a concrete pavement cannot be entirely eliminated. It can, however, be controlled.

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It is generally controlled by the introduction of expansion joints. It has been found that if a concrete pavement be constructed without expansion joints and subjected to the cycle of weather condi-

tions, that the cracking manifests itself under a fairly accurate rule of ascertainment.

USE EXPANSION JOINTS.

It is found that this pavement will crack transversely at distances varying from 25 to 30 feet. This has resulted in the introduction of expansion joints at from 25 to 30 feet. However, the introduction of an expansion joint must, of necessity, result in the employment of two different materials at the place where the expansion joint is introduced. These two materials are the concrete material forming the surface of the pavement and the material composing the expansion joint itself.

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If the material composing the expansion joint is destroyed either as the result of chemical disintegration or as the result of mechanical or physical destruction it no longer serves its purpose, and the concrete pavement at that point immediately becomes subjected to the primary destructive forces to which the concrete pavement itself is subject.

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These, to repeat, are principally shear and tension.

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The authorities seem to differ as to whether these expansion joints should be right angle joints or oblique. The theory of the oblique expansion joint is that the shear and tension is distributed over the joint at a different angle than over the right angle, thus reducing the destructive force.

RUTS AND PIT HOLES.

The other disintegrating weakness of the concrete pavement is its tendency to abrasion, owing to its being a rigid mass. This tendency manifests itself in ruts and pit holes which ultimately expose the surface to unevenness, breaking down under tension and shear.

The principal remedy for this defect in concrete is to cushion the surface. This is done either by spreading over the surface a preparation of tar, scattering over this stone chips, which is known as the Dolarway process, or by putting over a sheet surface more or less in the nature of an asphalt sheet surface.

CUSHION THE SURFACE.

The objection to the Dolarway process is that it seems to lack adhesion; that is, it has a tendency to flake off under traffic. The result is that it must be frequently renewed. This increases the cost of maintenance of the pavement.

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Neither is the cost of maintenance limited to the cost of respreading. This is so because the flaking of the surface is not uniform; so that, in order to prevent frequent resurfacing by Dolarway, owing to the flaking of old surface which has not developed failure at the time of patching, it is necessary to remove the old Dolarway coating by a solvent, so that the cost of maintenance must include both the old Dolarway removal and the new spreading.

JUST LIKE A FOUNDATION.

If the other surface is employed it can be readily

seen that the original concrete pavement in fact becomes a base, and there is a new surface possessing all of the characteristics of the sheet asphalt pavement. In order to prevent the creeping of such a surface it would probably require a bituminous binder to get proper adhesion.

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The result would be that the original concrete pavement would be converted into a sheet pavement of asphalt, involving all the failures and elements of repair and all the defects that an original asphalt pavement would possess, and quite closely approaching in cost the cost of an original asphalt pavement.

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These remarks are not to be construed as applying to the patented pavement known as the Hassam pavement, which will receive consideration later in this report.

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It might be well at this place to discuss some of the authorities with reference to concrete pavements. It has been earnestly urged at the hearings before us that a great deal of the failure of concrete pavements has been due to faulty specifications, dirty material, particularly sand and rock, and lax inspection, and this is undoubtedly true.

CAUSES OF FAILURE.

Your committee, however, is of the opinion that a great deal of the failure, or at least premature failure, is also due to the above causes.

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In the book known as "Highway Engineers' Handbook," Messrs. Harger & Bonney being the authors, the book being dated April, 1912, on page 81 is said:

> Solid concrete pavements have been tried, the best being the Hassam pavement which is sometimes especially reinforced to prevent cracks resulting from temperature or heaving. It is understood, however, that both transverse and longitudinal cracks have developed in this type of construction. This seems to be an inherent defect in all rigid types of construction for county roads.
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> Where the traffic comes directly on the concrete surface it often wears unevenly, failing in spots. This defect has led to the application of a thin wearing coat of bituminous material and stone screenings. How successful this will prove is still to be demonstrated.

On page 71 they say:

> The selection of the most economical top course that is suitable for a given road is the hardest problem of highway engineering. The relative economy of different constructions is theoretically expressed by the sum of the first cost and the capitalized cost of maintenance and renewal. The first can be readily estimated, but the cost of maintenance and renewal cannot be figured with any degree of accuracy for single special cases, and even on large systems it can only be approximated because of the new

factor of motor vehicle traffic. The life of any surfacing is comparatively short, a fact generally overlooked in most of the popular literature on Good Roads.

On any road the amount and class of traffic will fluctuate, and roads that are designated for light traffic will often fail under temporary heavy traffic which, for some reason, is diverted from its normal course. The first improved roads built in any locality will, for a time, carry more than their share of the traffic which is naturally reduced by the subsequent construction of adjacent improvements. It can readily be seen that it is difficult to judge the amount of traffic a road will handle, and that a short time traffic estimate is valueless as a basis for a definite conclusion. The design of the top course is usually based upon a comparison of the actions of the different kinds of previously improved roads that serve districts similar to that under consideration.

CEMENT EXPERIENCE TOO RECENT.

In the text book on "Roads and Pavements" by Frederic P. Spaulding, Professor of Civil Engineering, University of Missouri, and member of American Society of Civil Engineers, fourth edition, dated June, 1912, it is stated:

> The use of Portland cement as material for surface of sheet pavement has been in use in a small way since about 1895. Until 1909, however, these pavements were very few in number, and regarded as rather doubtful experi-

ments. Since 1900 there has been a considerable increase in the use of this material, and quite a number of cities have tried it to some extent.

Most of the work that has been done is of too recent date to show final results, or determine the best methods of construction. In several instances the earlier pavements have given good wear under moderate traffic, but more experience is necessary to determine the extent to which these materials may meet the requirements of more general use, and to formulate methods of construction to secure the best results.

The objects in most instances of engineers who have constructed pavements of this kind have been to secure pavements for moderate or light traffic at less cost than brick, or other satisfactory pavements, could be constructed. Several methods of construction have been patented and many, if not most, of the concrete pavements now in use have been constructed under some of these patents. These refer both to the composition of cement mortar or concrete employed for surfacing the pavement and to the method of construction.

Three types of construction have been used for pavements of this class—

(a) Mortar surfaced pavements, in which a surfacing of mortar is applied to an ordinary concrete foundation before the concrete has set,

in order that adhesion may develop between the mortar and concrete in setting;

(b) Monolithic concrete pavements, which consist of a single layer of concrete of the full thickness of the pavement;

(c) Grouted concrete pavements, constructed by first placing the coarse aggregate to the required thickness and then pouring a grout of cement mortar over the surface so as to fill the voids in the aggregate, which is rolled to a firm surface, either before or after the grout is applied.

Concrete pavements seem to give promise of considerable development in the immediate future, and it is probable that their use will rapidly extend.

In the Fourth Report of the Illinois Highway Commission, dated the 1st day of June, 1913, and covering the years 1910, 1911 and 1912, on page 82 it is said:

Concrete pavements present many characteristics totally unlike other forms of pavement in much more general use. A concrete pavement has a rigid monolithic surface and is properly to be classified a sheet pavement. Practically all forms of rigid surface pavements are of the block type, while other sheet pavements are somewhat resilient. The fact that concrete pavements are composed of large monolithic slabs, of rather brittle nature, having a coefficient of expansion due to temperature, differing not greatly from that of steel,

makes it necessary to consider certain features of construction not usually important in other forms of pavement.

The fact that a concrete road is rigid results in the surface layer becoming subjected to far greater impact stresses than is received by a pavement of a more resilient type.

The strength of concrete to resist stresses of all character depends upon the strength of the matrix or mortar holding the aggregate together, assuming that we have an aggregate of sound hard particles. The concrete being made of various sized particles held together by the matrix, it becomes necessary that none of these particles is loosened under the action of traffic.

IMPOSSIBLE TO PREVENT CRACKING.

Owing to the constant movement of a concrete pavement due to temperature changes, it is impossible to prevent cracks forming. On hot days the pavement tends to lengthen and on cold days to shorten. It is evident that the cracks form when the pavement tends to shorten.

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If the formation of cracks in a haphazard way is to be prevented, it will be necessary to provide joints close enough together that there will be sufficient strength in the concrete to drag one-half its length between joints. . . .

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The advantage of making the cracks beforehand is that their edges may be properly protected from traffic. It will be realized at the outset that the expansion joints constitute the weak points in the pavement and that there should be as few of them as possible.

INFLUENCE OF TEMPERATURE.

If a concrete pavement is laid without expansion joints, it might pass the first season without any serious consequences from buckling, as the cracks that are formed by the low temperature might not become sufficiently filled with incompressible material but that they afforded some relief as the pavement expanded under subsequent temperature rise. But as time goes on the cracks will become more and more filled with grit, become more nearly incompressible, so that in no very long time they will cease to be expansive and afford no opportunity for movement of the pavement, which movement must be taken up by deforming the concrete and the stresses that will be induced by such deformations are beyond what is to be expected a thin slab can withstand without buckling.

On page 87 of the same report it is said:

Like all other forms of road construction, if a concrete road is to give proper service it must have proper maintenance. Just what will be necessary to do to maintain properly a concrete road cannot be entirely foreseen owing to the

limited experience of this form of construction.

CEMENT REQUIRES MAINTENANCE.

Most uneven places in concrete roads are started by the formation of a crack, the edges of which will become broken down under traffic. That a crack forms shows that there has been movement of the concrete, and doubtless the cause resulting in the cracks still exists. If the cracks should become filled with incompressible material either by pouring in a thin grout or gradually filled with dust or grit from the road, there is every likelihood that the crack will expand under subsequent movement of the concrete slab.

It is believed that it is important to leave the concrete surface free to move, as it shows by the appearance of the cracks that it is necessary for it to do so. Therefore, as soon as cracks are formed, and a sharp lookout should be kept for them, they should be cleaned out as thoroughly as possible, and filled immediately with some plastic material, such as asphaltum pitch. This will prevent the water seeping through the cracks and also offer considerable protection to the edges, especially if the crevice is flushed with a slight excess of the pitch.

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In the University of Oregon Bulletin of January, 1913, in an article entitled "Concrete Roads vs. Macadam" by Prof. E. H. McAlister, Dean of the

School of Engineering of the University of Oregon, on page 5 it says:

WILL BE STANDARD HIGHWAY.

Considering its many merits, and the fact that in the long run it is relatively inexpensive, it seems probable that the concrete road, either with or without a bituminous wearing surface, will become the standard highway of the future.

IS MOST PROMISING MATERIAL.

On page 13 he says:

The writer favors a concrete base with a thin bituminous wearing surface, as adopted in New York and California.

On page 16 he says:

Standard types of city pavements, such as bitulithic or vitrified brick, are too expensive for the great majority of country roads, and concrete is the most promising material in sight that embodies at once a moderate first cost and reasonable maintenance charge.

In the Fifth Biennial Report, covering the period from 1912 to October 1st, 1914, of the State Highway Commission of the State of Washington, on page 128, in discussing the roads of Pierce County, Washington, it is said:

EXPERIENCE IN PIERCE COUNTY.

This county is the first in the state to undertake a large mileage of concrete pavements. In 1912 the construction of 8 miles of granitoid pavement was commenced in the Puyallup Val-

ley. This pavement has given excellent satisfaction, but the cost was excessive.

In 1913 the county commenced the construction of one-course concrete pavements, using 1:2:4 mixture. One contract of this kind of pavement was a failure on account of poor aggregate and lax inspection. This section has been used as a base for a standard sheet asphalt top.

Another contract gave a pavement which has been giving very good satisfaction up to date. Owing to the difficulty of controlling quality of aggregate the county installed a large gravel and sand pit near Lakeview, and undertook to furnish crushed and washed gravel and clean sand for all its contracts as well as its own work. . . .

The 1914 specifications for one-course pavements changed the proportions of aggregate and cement to 1:2:3½, and undertook a very rigid system of inspection and control of all features of the concrete work. The 1914 work is particularly noticeable for the careful attention given to special details, such as treatment of curves, shoulders, drains, expansion joints, etc.

LONG TIME TO SET.

With reference to concrete pavements, the time of construction becomes an important element, particularly considering the comparatively short season for favorable road construction in Western Oregon. It is pretty generally admitted that in all

types of concrete construction, with the exception of the Hassam pavement, that the concrete must be kept carefully dampened for a period of 7 or 8 days, and a period of 30 days should elapse before the pavement has sufficiently set to allow traffic upon it.

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This, of course, from the standpoint of interrupted traffic, is a considerable objection.

DATA IS LACKING.

As will be noted from the discussion of the authorities, there is very little data on the cost of maintenance of concrete roads. During the hearings of your committee it has been asserted that the cost of maintenance of a concrete road is so slight that it is not to be taken into consideration. Your committee, however, is not convinced of the soundness of this assertion.

HERE IS BEST DISCUSSION.

The best discussion of concrete country roads that has come to the attention of the committee is that by Mr. Paul E. Green, a member of the American Society of Civil Engineers, in a report he made to the authorities and taxpayers of Highland Park, Illinois. Mr. Green was commissioned by the taxpayers of that village, which is a suburb of the city of Chicago, Illinois, to make an inspection of the concrete road system as it then existed in Wayne County, Michigan. Mr. Green made his inspection in June, 1913.

He was employed for the reason that the authorities of Highland Park were desirous of im-

proving their thorofares, and wanted to ascertain the merits and faults of concrete road construction. On the general subject Mr. Green says:

DOUBTS UTILITY OF CONCRETE.

—The large proportion of failures observed by the writer has caused him to seriously doubt the utility of this product as a wearing surface, in cities especially.

While cracking will not be a serious defect as far as concerns the appearance on country roads, the writer has always believed that in city streets, where the value of abutting property is largely dependent upon the character of the street pavement, and is so recognized by the laws of practically all states, the tendency of concrete to crack and spawl is a serious objection to its use.

It has been maintained, however, by the advocates of concrete pavements, that much, if not all this cracking has been caused by improper specifications and that it can be eliminated by careful construction and also by proper reinforcement with steel. It is believed that this assertion is at least partially correct and that while such reinforcement will not eliminate this tendency entirely, it will reduce it largely. The steel reinforcement will, however, if used in the proper quantities and correctly and carefully placed, add a very appreciable item to the cost of construction.

Another weak point in the lasting qualities of concrete as a wearing surface, is the fact,

about which there can be little dispute, that it is deficient in its ability to withstand abrasive action. As long as the surface is smooth and perfect, the destructive effect of traffic is small, but if any break occurs, the ravelling action of iron-shod horses and iron-tired vehicles is very apparent and the action rapidly disintegrates the concrete, the surface soon becoming rutty and full of holes. This result is to be expected from the character of the material, since concrete will withstand a very considerable compression, but a very inconsiderable shear or tension. In reinforced concrete the allowable working stress for tension is rarely over one hundred (100) pounds per square inch; and for shear eighty (80) pounds per square inch; and for reinforced work these figures are reduced. Thus, when a hole is started in a concrete surface, it is exposed at its weakest points.

COMPARES PROS AND CONS.

Mr. Green gives the advantages and disadvantages of concrete pavements as follows:

Advantages.

1. Cheap first cost.
2. Dustless and sanitary.
3. Good appearance if no cracks appear.
4. Easily cleaned.

Disadvantages.

1. Liability of cracking.
2. Inability to withstand abrasive action.
3. Bad appearance after cracking.
4. If covered with bitumen, high maintenance charges.

He also gives his opinion that the proper location for such a pavement is:

First: Streets of light traffic (less than 100 vehicles per day).

O. K. FOR LIGHT TRAFFIC.

With reference to this he says:

It is quite possible that this figure is too low, but the writer is inclined not to change the figure, it being understood that the one hundred vehicles per day refers to iron-tired, horse-drawn vehicles.

WILL DO FOR SOME ROADS.

Continuing, he says:

Another proper location for such a road was stated to be country roads where the value of the property will not be affected by cracking, and on which two hundred and fifty vehicles per day would be considered a heavy traffic.

He gives a summary as follows:

Practically all cases of concrete pavements on city streets observed by the writer in the last five years have cracked badly before they are two years old. In most cases they are also badly worn.

The same statement is true of Windsor, Ontario.

Of the Wayne County roads observed, 32 per cent of the individual slabs of the 1909 work, 27 per cent of the 1910 work, 14 per cent of the 1911 work and 21 per cent of the

1912 work is cracking and showing signs of wear.

ARE WEARING BADLY.

All streets and roads observed which have a considerable commercial traffic, and which are more than one year old, are wearing badly; as, for example, Gratiot, River and Mack roads, in Wayne County, Michigan; Park Street, Windsor, Ontario; Ohio Street, Chicago; Green Bay road, Highland Park, Illinois, and many others.

To keep concrete roads and streets in good condition there must be constant maintenance the first year, and this maintenance will increase materially year after year. This maintenance may consist of tarring cracks and holes, or covering the entire surface with tar and sand. If the latter course is followed, the maintenance expense will amount to about 10c per square yard per year.

JOINTS ARE WEAK POINTS.

To reduce cracking and spawling to an unobjectionable minimum, it is necessary to reinforce the concrete and also to increase the number of expansion joints above those now generally used. These joints should be protected. Every joint, no matter what its character, is another point of weakness of the pavement and it is a debatable question whether it will not be well to go to the other extreme and eliminate all transverse expansion joints, use longitudinal expansion joints adjoin-

ing the curb only, let the cracks come when they will, and after their appearance—maintain them.

OTHER TYPES ARE SUPERIOR.

It is believed that a first class concrete road cannot be built for less than $1.60 to $1.75 per square yard, and at this it will be inferior to the cement grouted brick pavement, or an asphaltic concrete pavement, or bitulithic pavement or a sheet asphalt pavement, any of which can be constructed at this price, or at a slight increase over these figures.

The reason for this is because of its inability to stand abrasion.

ANALYSES MICHIGAN FIGURES.

In Mr. Green's report he comments upon the assertion as to the Wayne County roads, dealing with the cost of maintenance, the assertion being that only $200 was expended in 1911 and $100 in 1912 on the 65 miles of concrete highway in Wayne County, Michigan, from which, however, must be eliminated the 1912 construction of 40 miles, which was too recent at the time of his investigation to take into consideration the cost of its repair and maintenance.

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Mr. Green points out that the report of the Commission credits certain Dolarway treatment of concrete roads to the cost of experimental road work, when, as a matter of fact, it should have been credited to the maintenance account. He also estimates that, if the cracks as discovered by him in

the road system were properly repaired that the cost of maintenance of the system would be as follows:

Joints and cracks for 1912	$1,427.30
Joints and cracks for 1913	2,378.84
Holes	820.40
Surfacing with Dolarway 1912 and 1913	3,425.18
Total	$8,051.72

And, he says that in addition to this it would require not less than $1,000 to put back road in good condition, making a grand total for maintenance to date of $9,051.72, or about $140 per mile, if the entire mileage of 65 miles is considered; or about $226 per mile if only work constructed previous to 1912 is considered.

And he concludes this discussion in this way:

> This figure is the minimum figure possible; relates to the surface of the pavement alone, and takes no account of ditching, draining, hauling, replacing entire slabs, etc. In fact, it is the opinion of the writer, after talking to the foreman making repairs, that the actual maintenance is $5,000 more than this.

IS COSTLY TO MAINTAIN.

It thus appears that a concrete pavement, as above discussed, is an expensive pavement to maintain, and the opinion of your committee is that a concrete construction should be limited to a base and not used for the surface. It is the understanding of your committee that a concrete pavement can

be laid for an average price ranging from $1.04 to $1.10.

CANNOT USE EXISTING FOUNDATION.

There is another matter to be taken into consideration, and that is that a considerable portion of the contemplated mileage improvement is now improved with a macadam surface. If concrete were employed it would be necessary to take up this macadam surface, and if the material could be utilized in concrete construction it would have to be cleaned and broken to proper sizes.

However, this is not as much of an objection if concrete is employed as it would be to other types of pavement which would require the destruction of this macadam base. This is so because of the cheapness of the original construction of concrete. The objection to concrete is the objection to the probable cost of its maintenance, and if the pavement were to fail badly, as it often has done, the necessity of having to put in entirely new slabs, which would require at least thirty days before such repaired sections could be opened to traffic.

HASSAM IS AN EXCEPTION.

The above discussion in no way is to be taken as applying to the patent pavement known as Hassam. This pavement will now be considered. It has been employed considerably in the city of Portland for street paving.

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It is composed of broken rock of designated sizes, grouted with cement. The surface is then spread over with a cement mortar, which is broomed in by

a rough brush. The prevailing practice of the Hassam Company is not to establish expansion joints, but allow cracks to appear where they will.

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Some attempt has been made to fill cracks with tar after they appear, but the manager of the company states that this has not been particularly successful, owing to the fact that the cracks are surface cracks not extending in depth into the pavement any great distance, the result being that not much of a key is furnished for the holding of plastic material which is ordinarily employed in filling cracks in concrete pavements.

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We are informed that the cost of this pavement will range from $1.40 to $1.80 per square yard, depending upon the thickness of the pavement and local conditions.

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The oldest Hassam pavement seen in the city of Portland is that on Grand Avenue south of East Morrison Street. We are informed that this pavement has been down about six years. It shows much better behavior than any other concrete pavement which your committee has seen, and from the investigations of your committee the Hassam pavement is entitled to more consideration than any other concrete pavement that has been called to the attention of your investigators.

GOOD AND WEAK POINTS.

It does crack, however; these cracks are both transverse and longitudinal. It shows evidence in

places of both abrasion and pit holes. There is raveling, principally confined, however, to the end of the day's run. Its behavior with reference to its proximity to street car rails is the best of any pavement we have seen.

EXPENSIVE TO REPAIR.

Your committee is unable to form an opinion as to just what the ultimate life of the surface of the Hassam pavement will be. In the opinion of your committee, however, in case of the destruction under traffic of the Hassam pavement, it would be an expensive pavement to repair. The patent rights of the Hassam Company will be discussed elsewhere in this report.

RESULTS MUCH MORE SATISFACTORY.

It has been stated by the present manager of the Hassam Company in Portland that a good deal of the Hassam pavement laid in Portland before 1911 has been unsatisfactory owing to the lack of interest of contractors in the pavement itself; but that since the Hassam Company are laying the pavement much greater care has been taken and the results have been much more satisfactory. In the opinion of your committee Hassam pavements since 1911 have been laid with greater care in Portland than before that time, and the result is noticeable with reference to pavements laid before and after that time—much more favorable to those laid subsequent to 1911.

TWO ASPHALTIC CONCRETE TYPES.

The next sheet pavement which we desire to dis-

cuss is the asphaltic concrete pavement. There are two general types of this pavement—that laid by the Warren Construction Company or by others under royalty license from them, which is known as the bitulithic or Warrenite. The other is an asphaltic concrete pavement which is laid under what are known as the Topeka specifications.

WARRENITE DISCUSSED HERE.

Our attention will first be given to the Warren product. It is not necessary, at this time, to discuss the Warren patents as that is reserved for later consideration.

It may be stated that pavements laid under the Warren patent are designated as bitulithic or Warrenite. There seems to be no substantial difference between bitulithic pavement and the Warrenite pavement, although there is considerable difference of opinion as to just what type of pavement is contemplated by each of these two designations.

It has been stated to us that the bitulithic pavement is one in which the ingredients entering the mixing pot are those that are weighted on a multiple beam scale; that the Warrenite pavement is one in which the ingredients are measured instead of being weighed.

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It has also been stated that the difference is this: that the bitulithic pavement has a greater thickness than a Warrenite pavement, but the explanation as given by a member of the firm of Warren Bros. is that there is no distinction other than this—that the company always lays a bitulithic

pavement in cities and a Warrenite pavement outside of cities.

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If this distinction be taken as correct, it appears that the only difference is in designation for specific purposes, and that bitulithic and Warrenite are merely trade names.

Bitulithic pavement has been laid upon streets in the city of Portland since 1903, and your committee has found plenty of examples from which to form an estimate of the behavior of this pavement.

LAID ELEVEN YEARS.

Fifth Street, from Jefferson north with the exception of a block between Morrison and Alder was paved with Warren's bitulithic in 1903 or 1904. At the present time the street is in good condition except along the street car rails. This street has been repaired.

NATURE OF REPAIRS.

No figure as to the cost of repairs to this street have been obtainable by your committee. It is claimed by Warren Bros. that the only repairs made to this street have been those caused by the settlement of foundation areas due to excavating in the laying of water pipes and other street furniture, and the subjecting of the surface of the street to a flush coating which forms a thin bituminous cushion surface, the purpose being to seal the surface of the street to keep it waterproof.

BEST PAVEMENT IN CITY.

Others have claimed, however, that this street,

in certain places, has been subjected to a heavy asphalt cushion due to failure developing in the street. However, your committee is of the opinion that Fifth Street, considering the traffic upon it, is the best pavement in the city of Portland, and it gives every indication of having a future life of a great many years.

ABSENCE OF CRACKING.

No cracks have developed in this street that your committee has been able to find, and this absence of cracking seems to be characteristic of Warren's bitulithic pavement, and by virtue of this fact it is to be put in a class by itself when compared with other sheet surfaced streets. The advantage that it possesses in this particular is that it maintains a smooth surface taking compression and that there is no tension or shear upon its surface because it does not crack.

ONLY FOUND ONE BAD PLACE.

Your committee has only found in its inspection of many bitulithic streets in the city of Portland and its inspection of Warrenite pavement within the vicinity of Portland one spot where cracks have developed in a bitulithic pavement.

SOME FAILURES NOTED.

A number of failures of Warren's bitulithic pavement have been called to the attention of your committee. Second Street in the city of Portland has undoubtedly given the Warren people a great deal of trouble. The same is true of Grand Avenue, north of Morrison Street, and your committee has

heard of a failure developing in the city of Eugene, Oregon, as well as some of the Warrenite pavement laid on the county roads in King County, Washington.

OPINION ON FAILURES.

But, your committee is of the opinion that this percentage of failures is small when compared with the large percentage of successes that this pavement has shown under traffic conditions varying in volume and covering a period of years all the way from 8 to 11 or 12.

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In regard to the failures of the Warrenite pavement in King County, Washington, the Warrens maintain, and your committee believes it to be true, that these pavements were laid by contractors, under license royalty, and in several instances the contractors were inexperienced, while in others sufficient supervision and care were not taken either in mixing or in laying.

The failure in Eugene was probably due to a bad foundation problem as it is well known that the street in Eugene which was laid with bitulithic presented a bad foundation problem owing to the low flat nature of the street.

COMMITTEE IN DOUBT.

Second Street in Portland was laid at a time when weather conditions were bad. In regard to the Warren pavement—it has been asserted that Warrens do not always lay a pavement up to their specifications, and that in case of repairs they have used a mixture which did not contain a bitulithic aggregation. In some instances your committee is

of the opinion that possibly the first assertion might be true, although your committee is in doubt on this point.

THIN COAT FOR REPAIRS.

In regard to the second assertion, the point is undoubtedly correct, and it seems to be admitted by the Warrens that in making repairs they cannot always use their preferred aggregate, owing to the fact that the surface to be repaired is so small in area that they could not employ the aggregate and make a neat repair and, therefore, they use less-sized particles in cases of that kind.

HOW SAMPLES ARE SELECTED.

A sample was shown your committee of a piece of pavement taken from Division Street near 30th in the city of Portland, which did not have the appearance of conforming to the bitulithic aggregate. Your committee requested the Warren people to make an investigation of this pavement. They did so, and submitted an analysis and a sample of the pavement which materially differed from the original sample shown to your committee.

COMMITTEE GETS OWN SAMPLE.

In all probability each side selected a sample most favorable to its position. It became necessary for one member of the committee to obtain an independent sample, which seems to possess the characteristics of standard bitulithic.

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It is but fair to the Warren Company to state, however, that this Division Street pavement was not laid by the Warren Construction Company. It

was laid by a company having license from the Warrens to lay it.

BEHAVIOR ON LINNTON ROAD.

There has been a great deal of talk concerning the behavior of the Warrenite pavement on the Linnton Road, Multnomah County. This pavement was laid about the year 1911 or '12. It has recently been flush coated at the cost of about 2 cents per square yard. At the edges it developed some failure.

It is claimed by the Warren people, however, that the county failed to run a header along the edges of this road, with the result that when the pavement was rolled it feathered out under the compression and it was these thin edges that developed failure.

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It was also asserted by the Warrens that the Linnton Road has a bad foundation problem, and that they would not desire or care to construct any more Warrenite pavement on the Linnton Road, unless the pavement were carried on a concrete base. The Warrens advocate that a flush coating on their bitulithic pavement be applied about once every five years, that this has a tendency to keep the pavement sealed and waterproof.

EFFECT OF WATER.

At this point it might be well to explain the failure of a street having an asphalt or asphaltic concrete surface as a result of the action of water upon its sheet surface. Water, if it stands any length of time upon a street of this character, has a tendency to disintegrate the asphaltum cement.

It has a tendency to cause the pavement to become brittle due to the volatilization of certain chemicals in the asphaltum.

When this occurs the pavement shows a lifeless surface, showing particles of sand over the surface and rapidly disintegrates. From this it can be readily seen that if the asphaltum loses its power to withstand compression and shear, there will be a shoving of sand particles and the crystallized asphalt with the result that holes develop and the pavement rapidly breaks down under tension and shear. Therefore it is necessary to keep the water out of an asphaltic concrete pavement, and this flush coating process of the Warrens seems to be resorted to for that purpose.

SIDE BY SIDE.

A good illustration of a street that has been flush coated and one that has not may be seen on Jefferson Street between Fifth and Sixth, in Portland; one-half of this street has been flush coated, the other half has not. The difference is quite noticeable.

SMALL COST OF MAINTENANCE.

There is another point about the Warren pavement which merits attention. Your committee is of the opinion that it can be easily and cheaply repaired, so that with the small maintenance cost the life of the pavement will cover the minimum period of 15 years as before referred to in this report. The ease of repair seems to be principally due to the fact that where the repair must be made by the incorporating of new material, it can be done

by building the pavement up without having to go down to any subfoundation. This is so because there seems to be perfect adhesion between the new repairing material and the old material. This is not true of an asphalt sheet pavement.

REPAIRS REQUIRE FINER MIXTURE.

It, however, may be said in this connection that where repairs of this character are made that a finer-sized mixture must be used in making the repair than in laying the original pavement. In the opinion of your committee the repairs by the adhesion of new material to old and the filling of holes would not even have to be resorted to if the foundation maintained its integrity, the principal repair being the flush coating of the surface of the road.

ITS SOURCE OF STRENGTH.

Your committee is of the opinion that inherently the Warren aggregate, by virtue of the employing of graded sizes of stone from 2 inches down to a fine powder, presents a pavement which is strong in its power to resist compression, irrespective of the asphalt binder employed in the mixture.

STONE, NOT BITUMEN, CARRIES WEIGHT.

In most sheet pavements employing the asphalt principle, the resistance to compression is obtained from the inherent stability of the asphalt or bitumen after it is set, while in the Warren pavement dependence is placed upon the stone in the aggregate rather than the asphalt.

BINDER IS MORE ELASTIC.

The result is that either a less amount of asphalt

may be used, owing to the arrangement of the stone sizes resulting in the reduction of the voids, or a grade of asphalt may be employed which results in a permanent binder which is soft and more oily, thereby resisting in a greater degree the volatilization and tendency to become brittle that asphalt develops as a result of its chemical failure.

WON'T DISPLACE EVEN WHEN WARM.

It has been asserted and your committee believes it to be true, that after the mixture in the bitulithic pavement has been spread upon the surface to be paved and rolled, that motor trucks can drive over it without a displacement as a result of the compression of this traffic. This is evidence of the fact that before the asphalt binder has cooled, as it must do before it can set, that the aggregate of stone in the mixture possesses an inherent stability of its own.

BROKEN STONE AND OLD MACADAM.

We will not dwell further upon these points at this time as they will be more fully discussed under the head of the Warren patents. It may be remarked, however, that this stability presented by the Warren pavement results in the employment of a different type of foundation without violating safe practice, for in this type of pavement we think it has been demonstrated beyond successful dispute—that under ordinary conditions a foundation of broken stone may be used for bitulithic or Warrenite pavement. The result of this would be to greatly reduce the cost of the

Warrenite pavement on those portions of the county roads which require new foundations. This is true unless other standard types of pavements can be successfully laid upon a similar foundation.

It would also allow the employing of the present macadam on those roads which are now surfaced with that material, but this is not of so much importance as in all probability a sheet asphalt pavement or a pavement of the Topeka specifications could use the same base.

HERE IS TOPEKA MIX.

We come now to the construction of the Topeka specifications. As will be more fully explained in the discussion of the Warren patents, the Topeka specifications were the result of the analysis of certain asphaltic concrete pavements laid in the city of Pittsburgh, Pa., a number of years ago.

It is not contended by the Warrens that a pavement of the Topeka specifications is an infringement on their patent. These pavements have been laid in the city of Portland, but are of recent date.

Your committee examined a number of them, and is of the opinion that this pavement, as far as they could tell from the pavements they saw, should be placed in the category of sheet asphalt pavements. They have been laid in Portland for about two years.

One pavement was put down in Springfield, Oregon, in the year 1911; and also in 1911 the street known as D Street in Salem.

MUCH IN VALLEY TOWNS.

A considerable amount of this pavement has

been laid in the Willamette Valley towns of Oregon.

The pavements that your committee saw in Portland, down about two years, have developed a tendency to crack, showing both transverse and longitudinal cracks.

DEVELOPS TENDENCY TO CRACK.

This cracking is analogous to the behavior of sheet asphalt streets.

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Your committee, however, is not able to absolutely classify this pavement.

HIGH PER CENT OF VOIDS.

It does know, however, that the pavement possesses more than 21 per cent voids and that the aggregate of material in the mixture, aside from the asphalt binder, possesses no inherent stability. Still, reliable evidence as to the good behavior of this pavement under traffic has been brought to the attention of your committee. It seems to have done well in Pittsburgh, where it was first employed, although after a time it appears to have been abandoned in Pittsburgh and was not employed again until used in Topeka, Kansas.

MEETS WITH MUCH FAVOR.

It seems to meet with favor upon the part of Mr. Linn White, the engineer of the South Park Board, Chicago, Illinois. Your committee has been unable to obtain data concerning the method employed in its repair or cost of its maintenance as it has been of too recent date to absolutely establish items of cost in this particular.

AT LEAST IS EQUAL OF ASPHALT.

It is the opinion of your committee that this pavement, if carefully laid, will be at least the equal of an asphalt street and probably better than an asphalt street, particularly if it could be repaired by the obtaining of adhesion to old and new material. Your committee is of the opinion that this adhesion can be obtained, as it finds that where bitulithic pavements are repaired, due to foundation failures, that, what in effect amounts to the material of Topeka specifications has been employed in the repair and proper adhesion has been obtained.

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One or two of the earlier streets of the Topeka specifications laid in Portland employed a flush coat similar to that used on the Warren's bitulithic. The more recent constructions under the Topeka specifications have employed a cement dust surfacing instead of the flush coat. There is no unanimous opinion as to the reason for the departure from the flush coat to the cement dust surfacing. It seems to have been brought about at the instance of the city.

PATENT ON FLUSH COAT.

The Warren Bros. claim that they informed the city that the use of this flush coat on a pavement of Topeka specifications violated one of their patent rights, as they claim to have a patent on the flush coat employed. On the other hand, it seems to be maintained by others that the flush coat is composed of but tar and sand and that the only right that the Warrens have is to the trade name

on some of the asphaltic oil entering into the flush coat as an ingredient. The patent right of the Warrens as to this flush coat will be discussed later.

SHEET ASPHALT PAVEMENTS.

We now arrive at a discussion of sheet asphalt pavements. This discussion can be brief. Asphalt is not suitable for country road construction as compared with other standard types.

First, because it is high in price;

Second, because it is slippery;

Third, because its chemical life is comparatively short;

Fourth, because of the difficulty of its repair.

We know of no advocate for a sheet asphalt surface on the contemplated county road improvement. If it were to be used on roads requiring the use of new foundations, it would require either a concrete base or a bituminous base. It is doubtful if the crushed rock base could be used. It could, however, be used on the old macadam base on roads where such a base exists.

REASON FOR FAILURES.

But, the principal objection to asphalt is that, more than any other pavement in existence, it must be attuned to traffic conditions; that is to say, where traffic is light the mixture should be different than where traffic is moderate, and should not be used at all where traffic is heavy. The failures of asphalt are due to its disintegrating as above pointed out, and also due to the fact that under light traffic it is apt to crack.

CONDITION OFTEN LIFELESS.

Your committee examined sheet asphalt pavements in Portland upon which there was little or no traffic and where the pavements had been down only two or three years; these pavements presented a lifeless condition and were full of cracks, and will go to pieces in a very short time, irrespective of the volume of traffic upon them. This is due to the fact that asphalt maintains its vital principal longer under the kneading process of moderate traffic, and if it is not given this kneading process it becomes brittle and develops, under expansion and contraction, numerous cracks which, of course, are great faults in any pavement, as they are readily torn to pieces by the destruction of traffic.

DISCUSSION OF PATENTS.

So much has been said about the legality of the Warren patents that your committee feels it necessary, at the expense of some length and slight repetition, to discuss this matter. From time to time during its investigation, the assertion has been made to your committee that the Warren patent covering Bitulithic and Warrenite pavements, and the patent covering the Warren flush coat mixture were invalid and had been held so by the Courts.

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It has also been claimed that the Warrens have always sought to avoid litigation on the merits of their patent rights. That in the various suits instituted by them to protect their patents, if they saw that the evidence of their opponents was

particularly strong, the policy of the Warrens was to make a compromise by agreeing that if their opponents in the litigation would consent to a decree to the effect that the Warren patents were valid and had been infringed, the Warrens would waive all royalty under their patents.

REVIEW OF LITIGATION.

In view of these assertions and claims, your committee deems it necessary to review the litigation as far as it has been able to find the same reported in the printed reports of the various courts.

MORAL RIGHT AT STAKE.

In regard to the general subject of patents your committee is of the opinion that if a patent for a pavement is valid that no sound reason can exist why the inventor or owner of the patent should not be entitled to the fruit of his genius in the form of a royalty.

This right is guaranteed to all inventors under the laws of their country.

A sound public policy justifies patent monopoly.

The protection of a patent furnishes strong incentive for inventive genius.

PUBLIC GETS THE BENEFIT.

The general public, in countless instances, has reaped great benefit which otherwise never would have been had not inventive endeavor had for its goal the hope of monetary reward held out by the limited monopoly that the patent laws give. The ultimate public benefit under the patent laws is that the public will, after the limited time has ex-

pired protecting a patent, have the use and benefit of the invention or discovery for all time, and that too, without charge or price for the discovery or invention, after the expiration of the patent period.

DEPENDS ON VALIDITY.

On the other hand if a patent be in fact invalid, then all reasons for the protection fails and the public is under no legal or moral duty whatsoever to compensate the holder of such illegal patent in the employment of the device or process when it becomes necessary or desirable to use the same.

HISTORY OF WARREN PATENT.

The Warren patent for a bitulithic or Warrenite pavement was granted to Frederick J. Warren on May 5, 1903, and bears serial number 727,505 and was for a new and useful improvement in street pavements. The patent has been attacked on the principal ground that the Warren method for street pavement was not new, had been used before, and therefore had, under the patent laws, been anticipated. Also, that under what is known as double patenting the patent was invalid. These claims are questions of fact, any one of which, if true, would invalidate the patent. They have all been passed on by the courts, as will hereafter be shown.

NATURE OF INVENTION.

The pavement that Warren invented has for its component parts broken stone in graded percentages from stone that will pass through a 2-inch ring and be retained by 1½-inch ring down to impal-

pable powder mixed with bitumen or coal tar; subjecting the graded stone and bitumen mixed together to heat, the stone and bitumen forming a conglomerate mass which is spread hot over a foundation of either concrete, bituminous base, broken stone or old macadam.

AVOIDING VOIDS THE OBJECT.

The mixing of the properly graded stone from two inches down, having added to it a certain percentage of impalpable powder fills the spaces between the stone of larger sizes. Thus it is claimed that the density of the large solid stone will result in a given mass with a less percentage of voids than the use of small particles. That this is true appears from the following example:

HERE IS A SIMPLE ILLUSTRATION.

Let a 3-inch cube of stone be placed in a box of close fit; now let the stone be broken into small particles; these particles will more than fill the box; the surplus of particles over the filled box is the result of the voids or interstices between the particles.

RESULTS OBTAINED.

The reduction of voids in the use of graded stone in mass results in three things:

First, a combination that resists in high degree compression or static force independent of the bituminous or coal tar binder;

Second, less voids to be filled by the binder, resulting in the destructive force of traffic being borne in a greater per cent upon the stone than upon the bitumen; and

Third, inasmuch as the bitumen that must carry a high percentage of compression must be of a grade so as to become hard when set, while a grade that is used for a binder remains more plastic after setting, the hard being more susceptible to disintegration under water than the soft, the result of the Warren patent was that less bitumen was used, and the grade less subject to water disintegration, thereby resulting in a pavement more impervious to the elements to which pavements must, of necessity, be subjected.

PRODUCT, NOT PROCESS.

Warren claimed his invention was a product, not a process; that is, he admitted that before his invention broken stone, bitumen or coal tar and stone powder had been used in combination for paving. He made no claim for a patent based upon the novelty of the process, but he did claim that the process before his patent was confined to layer combination resulting in a pavement having no inherent stability and having more than 21 per cent of voids.

CASES ARE CITED.

In cases in which the Warren patent No. 727,505 has been before the courts the courts have upheld the Warren patent with the exception of one in which the Warrens dismissed their suit for infringement after the court had denied them a preliminary injunction.

In this case, after the denial of the preliminary injunction, the suit was still before the court on the merits of the Warren patent, particularly with

reference to the question of anticipation or prior use. This was a case in which the Warrens claimed the city of Chicago, through its South Park Board, and a paving contractor, were infringing patent No. 727,505. The opinion of the court was never reported in the law reports. The detail of as much of it as we have been able to obtain will appear elsewhere in this report.

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We will now consider the reported cases with reference to Patent No. 727,505 in the order in which they appear in the books.

The first is the case of Warren Bros. Co. vs. City of Owosso, decided on January 13, 1909, and reported in No. 166 Federal Reporter, page 309. This was an opinion by the United States Circuit Court of Appeals for the Sixth Circuit. In a patent case under the act of Congress of March 3, 1891, the judgment or decree of the United States Court of Appeals is final within the territorial limits of its jurisdiction and beyond its territorial limits is followed on points of law by other United States trial and intermediary appellate courts under the rule of comity.

Also by the Act of March 3, 1891, the Supreme Court of the United States may review the final judgment or decree of the United States Circuit Court of Appeals when, as questions of law they are certified to it by the United States Circuit Court of Appeals or by a writ of certiorari or otherwise issued by the Supreme Court itself. The practice of the Supreme Court, however, as we

understand it, is not to issue any such writ unless United States Circuit Courts of Appeals in the various circuits hold contrary opinions on the same points of law. The object of the writ of certiorari being to have the Supreme Court of the United States establish uniformity of law throughout the United States when two or more Circuit Courts of Appeals of the United States in different circuits have ruled differently on such points of law.

The bearing of the above on the Warren patent is this: that two circuit courts of appeals in different circuits have upheld the Warren patent, and one circuit court up to the present time has held the patent to be invalid.

STATUS IN SUPREME COURT.

The result of this is that in the absence of an adverse ruling the Supreme Court of the United States will not take jurisdiction of the validity of the patent. In fact, it appears that the United States Supreme Court has declined to issue a writ of certiorari with reference to the patent. This is not saying, however, that the refusal to issue the writ was an adjudication on the patent.

We are of the opinion that if any United States Circuit Court of Appeals held the patent invalid that the Supreme Court of the United States will take jurisdiction of the case and decide the same as it sees fit on the merits.

For all present purposes of litigation, however, the Warren patent has reached final adjudication on its merits under the rule of comity, unless it is

possible to produce new evidence on the subject of anticipation or prior use.

But to return to the Owosso case.

In this case Judge Lurton upheld the patent, holding that the evidence did not show prior use or anticipation, and, in effect holding that the patent was not invalid on account of double patenting. This is the leading case on the Warren patent No. 727,505.

This case has been criticised, it being contended that the defense to be alleged infringement was conducted by the Barber Asphalt Co., it being a party defendant with the City of Owosso; and that the Barber Co. intentionally made a weak defense.

It is also asserted that the principal evidence in the case, with reference to prior use, was an abandoned sidewalk constructed in front of the asphalt company at Long Island City, New York.

It is also maintained that the Court made a distinction between anticipation in the use of a sidewalk and a street pavement. We think, however, that the alleged weak defense theory is not borne out, nor is the assertion that the Court passed its ruling entirely on the sidewalk case.

QUOTES COURT DECISIONS.

In this we do not restrict ourselves to our own opinion in the matter, but cite the language of the United States Circuit Court of Appeals for the Second District, in the case of Warren Bros. vs. the City of New York, 187 Federal Reporter, page 831, in which case on page 835 the Court says:

It is stated that in the Owosso suit the only defense made to the patent was an assertion of its invalidity by reason of a single instance of prior use in the shape of a sidewalk laid at Long Island City.

Reference to the Owosso record, however, shows numerous prior patents and prior publications introduced and commented upon by expert witnesses, and page after page of discussion of the art generally and of the meaning of the specifications and claims of this and other patents taken out by Warren and others. The most cursory examination shows that 1,800 pages were not wholly devoted to the history and characteristics of the pavement at Long Island City, and the opinion of the Circuit Court of Appeals shows that prior patents were discussed and considered.

Nor do your committee find that the Owosso opinion was based solely upon the distinction between a sidewalk and a pavement. On page 313, (166 Federal Reporter) in the Owosso case the Court says:

> Whether a patentable invention would be involved by employment of the same construction for roadway purposes which had been publicly employed for sidewalk purposes is another question, and one which we pretermit now as not necessarily presented upon the facts of this case.

The Court then goes on to review the evidence of the sidewalk. At page 315 it says:

> The sidewalk construction was much the closest approximation to the invention of Warren.

The Court then states the sidewalk to be an experiment and at page 317 says:

> The contention that the construction of this sidewalk was not an experiment, because it was laid upon a public highway and subjected to practical public use, does not take it from the category of experiments. It was a product which could only be tested with respect to its durability for pavement purposes by laying it upon a highway. The facts, in this respect, are similar to those of Elizabeth vs. Paving Co., 97 United States, 126, where it was held that Nicholson's pavement had not been in public use within the meaning of the patent law, because an experimental section had been laid down and used by the public for some six years before he applied for a patent. The use was held, upon the facts of the case, to have been purely an experimental one.

The next case in which this patent was called in question was that of Warren Bros. vs. City of Montgomery, 172 Federal Reporter 414. In this case the Warrens claimed that the specifications for the construction of a pavement on East Jeff Davis Avenue in the city of Montgomery, Alabama, was an infringement. In defense to this claim it was contended that the Warren patent had been anticipated by certain prior pavements in the city of Washington and by double patenting. The case

was decided in favor of the Warren Company. At page 421 the Court says:

> When the defense is anticipation, it must be shown, and, if there is any reasonable doubt on that point it must be resolved against the defendant, on a motion for a preliminary injunction (cases cited). In view of these principles, and after careful consideration of the new evidence regarding the Washington pavement, which was not before the Court in the Owosso litigation, but was before the Circuit Court of Illinois; this Court holds that the defense of anticipation is not made out.
>
> The substance of the other defenses, leaving out the question of infringement *vel non,* is that the patent does not disclose invention and that there have been double patents. On these points the Court is of the opinion that at this state of the proceeding it should follow the decision in Warren Bros. vs. Owosso, *supra.* While the decision does not discuss the question of double patenting, it inevitably overrules that defense.

The ruling of the Court in this case was that substantial justice would be done if defendants filed a bond in a given amount in addition to paying all costs and damages as may be awarded against defendants if, upon final hearing, it should be adjudged that the street paving in East Jeff Davis Avenue infringed any claim the complainant could lawfully set up under letters patent No. 727,505. This order of the Court reserved the right to litigate the

merits of the patent on final hearing. The final outcome of this case has not been available as far as your committee can find.

The next case was that of Warren Bros. vs. City of New York, 187 Federal Reporter 831. This was an appeal from the Circuit Court of the United States for the Southern District of New York from an order granting a preliminary injunction to the Warrens and the order of injunction was affirmed. The Circuit Court's opinion appears in the reported opinion of the United States Circuit Court of Appeals. In this litigation it was contended that the prior use of pavements in Washington, D. C., Chicago and Cincinnati were anticipations of the Warren patent. At page 833 the Circuit Court says:

> I have examined the affidavits and the specimens by both sides from Washington pavements and am confident that the testimony does not establish anticipation beyond a reasonable doubt. . . .
>
> The Cincinnati use is even more remote. The pavement there is laid in blocks and is not intended at all for vehicular traffic. The Chicago uses need not be discussed as they are no better references than those to which our attention has been called.

At page 826 the Court says:

> As to the three new alleged prior uses and the question of infringement, we are in entire accord with Judge Coxe's reasoning and conclusion.

The next case is that of the City of Grand Rapids vs. Warren Bros., 196 Federal Reporter 892. This was an appeal from an order of the Circuit Court granting Warren Bros. a preliminary injunction restraining defendant Seamans from paving a certain street in Grand Rapids under specifications that were an infringement on Warren's patent. The appeal was on a collateral issue. This case came before the District Court, Western Division, S. D. Michigan, on its merits in Warren Bros. vs. Grand Rapids, 216 Federal Reporter page 364. The question was whether certain specifications showing a mineral aggregate of less than 21 per cent of voids was an infringement of the Warren patent. At page 366 the Court says:

> The sole question here to be determined is this: Under the evidence and the ruling of the Circuit Court of Appeals of this circuit, will the wearing surface of a pavement constructed with the above specifications be an infringement of complainant's patent.

At page 367–368 the Court continues:

> For, assuming defendant's contention to be correct and viewing the evidence most favorably to them, the mineral aggregate produced by them, and which they claim will be used in the construction of the pavement, fairly falls within the claims of the patent. The tests made show conclusively that such a mineral aggregate when thoroughly mixed and properly compacted will have less than 21 per cent of voids or the required density of the patent

product. While such a mineral aggregate would not contain the inventor's preferred maximum sizes of stone, yet the evidence, which is at most but feebly contradicted, shows that it will contain the preferred proportions and the essential grades of sizes, and that it will have a useful degree of stability. Having the required elements of density and stability, the product must necessarily possess the "inherent stability" which is the broad and fundamental idea embodied in the invention and embraced in the patent. A decree will be entered enjoining the defendants from carrying out their contract for the construction of the Barclay Street pavement.

CELEBRATED TOPEKA CONTROVERSY.

There now remains the question of consent decrees in which it has been claimed that the Warrens have made agreements in litigation whereby they have waived their royalty in consideration that it be stipulated that decrees be entered upholding their patents. As near as we have been able to ascertain, the grounds for these claims seem to have originated in the litigation the Warrens had in Topeka, Kansas.

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No report of this Topeka case seems to appear in the printed law reports.

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As we gathered the facts it seems that in the case of Warren Bros. vs. the City of Topeka, the city had prepared specifications for pavements which

the Warrens sought to enjoin for infringement of their patents. On a hearing the City of Topeka defended their right on the ground that the Warren patent had been anticipated by the construction of an asphaltic concrete pavement on Lang Ave.; also Bellfield Ave. and Sherman St., in the city of Pittsburg, Pa., which pavements were constructed prior to 1898 and had been in constant use from date of construction until the present time (August, 1909) and were in good condition:

> That said asphaltic concrete pavements were composed of a mixture of crushed stone, sand and bituminous cement so proportioned and mixed as to produce enough bituminous mortar from the finer particles of stone, the sand and bituminous cement to fill all the voids or interstices of the stone and produce a solid homogeneous mass, free from voids.

These facts were supported by the affidavits of Joseph H. Ryan, superintendent of the City Asphalt Paving Plant, Wm. D. Hamilton, an employee of the Department of Public Works of Pittsburg and James Martin, a resident of Sherman St., in said city, having lived on that street for a period of about eleven years. The Warrens contended that the Pittsburg streets were not of a density having less than 21 per cent voids, which the specifications under which Topeka was seeking to lay pavements did have. They said that they did not consider the specifications of the Pittsburg streets as being an infringement of their patents—that if the Topeka

people wanted to lay pavements like the Pittsburg pavements to go ahead and do so.

TOPEKA ABANDONED ATTEMPT.

The outcome of the case seems to have been that the city of Topeka abandoned its attempt to lay pavements under the specifications upon which it was sued and laid pavements after the Pittsburg specifications which was not contested by the Warrens. This is the original, as we understand, of the now famous Topeka specifications for asphaltic concrete.

ALLEGED BREAKING OF PATENT.

The next case is that of Warren Bros. vs. City of Creston, Iowa et al. In this case it has been claimed that the Warren patent was broken. In this we are unable to concur. The material part of the decree is conclusive on the point; it is as follows:

Thereupon it was agreed that the following decree might be forthwith entered as hereinafter specified. And, it appearing to the satisfaction of the Court that the specifications for the work as constructed by the defendant City of Creston, Iowa, requires said contractors to use in the construction of the wearing surface of the pavement contracted to be built in said city of Creston, Iowa, no particles of stone that would not pass a screen with openings ½ in diameter, and that less than ten per cent of the stone or coarse sand would be retained upon a screen with openings ¼ in diameter, and all the remaining mineral matter used should be finer than ¼ in diameter.

And it further appearing that the pavement constructed by the use of mineral particles as above described would not infringe the claims of complainant's patent in this case, No. 695,421, and it further appearing that the pavement to be constructed in said city of Creston, Iowa, will be constructed in substantial compliance with the following formula, to wit:

Bitumen	from 7 to 11%
Mineral aggregate passing 200 mesh screen	from 5 to 11%
Mineral aggregate passing 40 mesh screen	from 18 to 30%
Mineral aggregate passing 10 mesh screen	from 25 to 55%
Mineral aggregate passing 4 mesh screen	from 8 to 22%
Mineral aggregate passing 2 mesh screen	less than 10%

same to be used in the order named and that the said pavement so constructed will not infringe the claims of said patent.

It is, therefore, ordered that the matters in controversy between the parties litigant having been settled in accordance with the above findings, the bill heretofore filed in this case be dismissed without costs as against either party.

Done and ordered of record this June 16th, 1910.

(Signed) SMITH McPHERSON,
Judge.

CASE ADJUSTED WITHOUT TRIAL.

We have now arrived at that point when it is

necessary to consider the South Park Board Chicago case. There can be no doubt about it—the Warrens failed to obtain a preliminary injunction for the infringement of their patent. This left the case for trial on its merits. It was never tried. The contractor not being prevented by a preliminary injunction finished his contract. An affidavit by J. M. Head, General Counsel for Warren Bros. filed in the case of Warren Bros. vs. City of New York above discussed, says of this case:

> That he has heretofore filed an affidavit in this case and that as General Counsel for Warren Bros. he was present in the City of Chicago, Illinois, and took part as counsel in the ex parte application for a preliminary injunction against the South Park Commissioners and Metropolitan Construction Company to prevent the construction of a street pavement on Michigan Boulevard in said city of Chicago, which construction, it was claimed, would infringe the patent No. 727,505, owned by Warren Bros. Co., covering a street pavement; that at the hearing of said application and after the argument had progressed for some time the defendants brought before the Court and exhibited a section of street pavement, which it was claimed had been taken from one of the streets of the City of Washington, D. C., and which it was claimed had been laid during the year 1872 or 1873; and was offered as an evidence of a pavement construction which anticipated the claims of the Warren Patent.

Affiant states that the section of pavement exhibited appeared on its face to anticipate the claims of said patent, and evidently made such an impression upon the mind of the Court that upon presentation of that exhibit the Court felt constrained to refuse the issuance of the preliminary injunction and so stated in making the order in the case.

VALIDITY ACKNOWLEDGED BY CONTRACTOR.

Affiant further states that immediately thereafter further steps were taken to make a thorough examination of the contract and specifications under which said pavement had been laid in the city of Washington; and also to make a careful examination and analysis of the same; and that as soon as said examination had been made, affiant undertook to renew the application for the preliminary injunction before Judge Kohlsaat but was unable to secure a hearing before him, owing to the fact that it was then midsummer and the Judge intended to leave the city until after vacation; at Judge Kohlsaat's suggestion, affiant then attempted to have a re-hearing before Judge Sanborn but was unable to secure a day until early in September during which time the work had been vigorously prosecuted and a large portion of the street torn up and rendered unfit for use; affiant further states that owing to the fact that this street had been torn up and rendered impassable for traffic affiant realized that it

would be impossible to secure the issuance of a preliminary injunction to prevent the further prosecution of work at that time, and the application for said injunction was, therefore, never argued; affiant further states that before further legal steps were taken in this case the contractor to whom the contract for the improvement of Michigan Boulevard had been awarded, compromised and settled its differences with complainant and accepted a license acknowledging the validity and agreeing to use the patent of complainant in further construction of street pavements; that, therefore, the complainant dismissed its suit against South Park Commission and Metropolitan Construction Company, the matter having been settled and adjusted.

ANOTHER VIEW OF SAME CASE.

With reference to this Chicago case, Linn White, Chief Engineer of the South Park Commission, Chicago, Illinois, in an address before the Civil Engineers' Society of St. Paul, on April 7th, 1913, says:

> Some litigation was had in Chicago with the Bitulithic Company, of which the following is a brief statement; in 1909, when the South Park Commissioners let a contract for paving Michigan Avenue from 12th to Jackson Streets with asphaltic concrete, the Bitulithic Company sought an injunction in the Federal Circuit Court. The injunction was denied by one judge but under some legal technicality the

case was reopened before another Federal judge in the same circuit. The injunction was again denied, and as this left the case before the Court in such a shape that any further action would have to be a trial on its merits, the complainants dismissed the complaint and no attempt has since been made to renew it. To reach this partial conclusion in the Courts required over a year, and of course, before then the contract over which the litigation started was completed and the pavement in use. The South Park Commissioners, however, had proceeded to lay other considerable quantities of similar pavements and if good grounds for an injunction had been shown the result would have been to force them to come to terms with the Bitulithic Company and account for royalties in both past and future work. Up to date, considerably over a million yards of asphaltic concrete pavement has been laid in Chicago, and the royalties would amount to a considerable sum.

COMMITTEE ON LAW POINTS.

From the facts as your committee has been able to obtain them, it would seem, with the possible exception of the Chicago case, that the patent has been fully sustained in the courts. It is also a noteworthy fact that the alleged Washington anticipation before the Court in the Chicago case has been held by other courts not to be considered anticipations.

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Of course, as your committee has heretofore intimated, the question of the Warren patents has not been fully closed and probably never will be, for it is always open to the introduction of evidence of new alleged anticipations that have never been before the courts.

ADVISES AGAINST LITIGATION.

However, for this county to litigate with the Warrens the validity of their patent would mean protracted litigation, which would greatly delay highway construction.

MAIN POINT IS ULTIMATE COST.

After all, the point is not whether the Warren patent is valid, but whether the Warren Pavement, with the royalty to be paid in connection with their original cost plus maintenance, is the cheapest pavement in the long run for the county.

PATENT ON FLUSH COAT.

There now remains to be disposed of the question of Warren's patent for their flush coating process.

This patent is No. 695,422, which must be taken with their patents for machine for spreading the flush coat, which are Nos. 791,726 and 691,708. All these patents were sustained by the United States District Court for the Western District of Texas, El Paso Division, by a decree entered in the case of Warren Bros. Co. vs. John Eubank et al., entered on the 13th day of April, 1915. Whether this suit will be appealed we are unable to state. This seems

to be the only case in which the just above named patent rights have been litigated.

DISCUSSES HASSAM PATENTS.

In conclusion on the subject of patents, we desire to discuss the letters patent for the Hassam pavement.

These bear serial Nos. 819,652 and 851,625. These patents were sustained in the District Court of the United States for the District of Oregon by a decree in the case of Hassam Paving Co. et al. vs. Consolidated Contract Co. et al. This decree was filed April 27, 1914. We understand that this suit has been appealed to the United States Circuit Court of Appeals and is now pending there. As far as we have been able to find, the above suit is the only one in which the Hassam pavement has been in litigation.

WOOD BLOCK SHOULD BE TRIED.

During these hearings your committee took the testimony of several gentlemen interested in wood block pavements. However, we understand that the trustees of the Chamber of Commerce have passed a resolution favoring a trial of wood block pavement. Under these circumstances, your committee feels that the trustees have acted upon the special matter of wood block pavement so that little need be said further than what has been heretofore in this report said concerning the general type and behavior of such pavements.

Your committee is unanimous that experiment be made with wood block; however, we think that the experimental pavement should be confined to

units of one mile each and on different roads, and that the experiment be limited to three miles of wood paving. In view of the fact that this pavement in its cost will exceed other standard types, it is thought advisable that the difference in cost be taken care of by those interested in the wood block pavement.

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HERE ARE MAIN RECOMMENDATIONS.

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As a general recommendation, your committee recommends that on grades and sharp curves either brick or Belgian blocks be employed; that if a Belgian block pavement can be laid as cheaply as a vitrified brick pavement on grades and curves, that stone blocks be employed in preference to brick, as it will furnish an avenue for the employment of an Oregon product.

Your committee further recommends that the Warren pavement be employed on the majority of the mileage for the contemplated hard surface improvements of the county.

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In arriving at this conclusion your committee hesitated somewhat in this recommendation as against an asphaltic concrete pavement of the Topeka specifications, and its preference for Warrenite over Topeka is due to the fact that it has been unable to ascertain what the cost of maintenance of the Topeka pavement would be, measured by the minimum period of 15 years, which your

committee believes should be the basis for determining the maintenance charge.

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If, however, a pavement of the Topeka specifications is to be considered, the question of type of foundation becomes an important one. It would seem to your committee that this pavement, if requiring a new foundation, should have a foundation of either a concrete base or the bituminous base which, of course, would eliminate a crushed rock base.

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Your committee is of the opinion, however, that if the Topeka specification pavement were to be used on the roads at the present time improved with macadam, that the macadam base would furnish a sufficient foundation for this pavement. To again emphasize the point of your committee, it eliminates asphaltic concrete of the Topeka specifications and gives preference to Warrenite purely upon the ground of lack of information with reference to the probable life and cost of maintenance of the pavement of the Topeka specifications.

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During our investigations it was stated to us by a member of the firm of Warren Bros. that it was the policy of their company, when their pavement was used, not to exact royalty for future flush coating or for repairs with the Warren mixture. This, of course, should be reduced to contract form so that there can be no possible misunderstanding upon this point. The opportunity for the county

to avail itself of such privileges if it may so desire, without the payment of royalty, of course is of vital importance.

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Your committee is unable to recommend the use of sheet asphalt pavement on the county highways owing to the fact that when damp it is extremely slippery; also, your committee is convinced that the cost of repairs for this type of pavement is comparatively high.

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Your committee, at this time, does not deem it necessary to discuss the question of a separate maintenance contract for the pavements after they are once laid, as it understands that this matter has been satisfactorily disposed of by asking for bids for maintenance under a contract separate from the specifications that call for bids for original construction.

CONFIDENCE IN JOHN B. YEON.

In conclusion, your committee takes this opportunity to express its confidence in the honesty and integrity of Mr. John B. Yeon, roadmaster of the county. Mr. Yeon, without compensation, is giving all of his time and abilities to this very commendable plan of constructing a permanent highway system. Your committee has found him well grounded and informed on the subject of pavements, and it is the opinion of your committee that the only motive Mr. Yeon has in his views and activities is that of obtaining the very best pavement for the least amount of money. By this we

do not mean the cheapest pavement in first cost, but the pavement that will ultimately be the cheapest. Whether Mr. Yeon is mistaken in his conclusions, whether your committee is mistaken in its conclusions, can only be revealed by the future.

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But, of this we are certain—that everybody concerned in this paving problem who is entirely disinterested has been and is now seeking to get the very best available pavement for the county, because it is realized that in so doing the county will be furnishing an object lesson which will be an incentive to depart from the unwise policy of the past, which has resulted in throwing money away for useless macadam roads.

Respectfully submitted,
F. W. MULKEY, Chairman,
RODNEY L. GLISAN.
FRANK McCRILLIS.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 22.

MR. YEON'S REPORT.

Following is the full text of Roadmaster John B. Yeon's report, with reference to types of paving

and awards of contract for Multnomah County hard-surfacing under the recent bond issue.

Hon. Board of County Commissioners—

Gentlemen:—

As per your order of June 15, 1915, referring to the tabulation, conference and recommendation, with your Honorable Body, I have the honor to submit to you the following report and recommendations for the awarding of contracts for paving the County Roads under the recent Bond Issue of $1,250,000.

I have given each of the different types of pavement bid on careful study and investigation, and have gone into the analysis of the bids fully and with the intention of looking after the best interest of the tax-payers of Multnomah County.

Each section of each road has been considered as a separate bid, and the bids compared on the basis of lowest responsible bidder for the type of pavement best suited for that particular locality, the type of transportation, and further increase of traffic.

Due weight has been given the type of pavement best suited for this climate and on the new subgrades where settlement is likely to occur, or on dangerous curves or grades.

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In my recommendation I have endeavored to choose a pavement with the best point, taking into consideration the money available, as well as the lowest responsible bidder.

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SAFE GRADES—The pavements on safe grades, up to 5 per cent., have been chosen with the following points in view:

First, cost, maintenance cost, imperviousness, resiliency, density, stability, noiselessness, dustlessness, and a pavement that will be easy on the eye; afford a good footing for horses as well as for rubber tires; one that will not crack and will show least abrasion; one that has least tendency among the asphaltic concretes to wave, creep, mark or displace.

Time and ease of construction are two of the most important points taken into consideration, as these two points have a direct bearing on the obstruction of traffic and the resulting inconvenience and loss therefrom.

Consideration has been given the maintenance cost after the first period of ten years and the pavement chosen which will be least expensive to resurface at the end of that time or at a later time.

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STEEP GRADES AND CURVES—On steep grades and curves a pavement has been chosen that will offer the best footing, either because it has a naturally rough surface or because it can be given a rough finish.

In the choosing of these pavements it was necessary to choose the best type for the available money with due regard to the lowest responsible bidder.

REMARKS ON ASPHALTIC CONCRETE NO. 2—I do not favor Asphaltic Concrete No. 2 (Modified Topeka) for the following reasons: High cost

of maintenance, general lack of stability, slipperiness, tendency to creep and tendency to wave. This pavement has not given satisfaction as a highway pavement and is still more or less in the experimental stage.

One of the best arguments against it is the fact that few bids were received on this type, and the general desire to dodge the maintenance.

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REMARKS ON CONCRETE—I do not favor the use of concrete, excepting on steep grades, and then only the Wayne County Specifications (Cement Concrete No. 1) with roughened surface.

Concrete has a tendency to crack and does crack on all roads where it has been laid, thus allowing the water to penetrate to the subgrade. When repaired this crack causes a severe impact from wheels with raveling or increased abrasion. Expansion joints cause the same result.

Concrete is a good base for a bituminous surface but the fact remains that it is much cheaper to build it in that manner at first instead of using bitumen as a final wearing surface, thus saving the cost between a concrete pavement and a concrete base, which is a large item.

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SUMMED UP—I have the following reasons for believing that a concrete pavement is not good in highway construction without a bituminous wearing surface:

Concrete is brittle, hard and unyielding; dusty, noisy and unsightly. Its tendency to crack is a

serious fault, and the difficulty of resurfacing and repairing makes the final maintenance expensive.

The glare from a concrete pavement causes machines to avoid it, and is a serious objection.

Concrete cannot be used for 30 days after construction or repairs, and the construction is slow work, and results in inconvenience to transportation. This would not only mean the closing of the highway to all traffic during construction but for 30 days after, on each division. On the Columbia River Highway where there are fills that cannot be paved this year, it would mean the closing of traffic next year during construction and 30 days thereafter. Any repairs removing concrete would close the road to traffic for at least 35 days.

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No consideration has been given bids which would be liable to involve the County in law-suits, and only pavements have been recommended which come within the available bond issue for each road.

COLUMBIA RIVER HIGHWAY, ESTIMATE $468,007.00

I recommend, that Section "A," Columbia River Highway be awarded to the Warren Construction Company, at the unit prices bid for Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed stone base, Totaling.....$121,077.52

I recommend that Section "B," Columbia River Highway be awarded to the Warren Construction Company, at the unit prices bid for Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed stone base, Totaling..... 29,806.62

I recommend that Section "C," Columbia River Highway be awarded to the Warren Construction Company, at the unit prices bid for Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed stone base, Totaling..... 137,279.50

I recommend that Section "D," Columbia River Highway be awarded to the Pacific Bridge Company, at the unit prices bid for Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed base, Totaling 155,332.78

I recommend that Section "E," Columbia River Highway be awarded to Boyajohn-Arnold and Hans Pederson, at the unit prices bid for brick on a *concrete base,* Totaling..... 22,921.66

TOTAL BID $466,418.08

SANDY ROAD, ESTIMATE $221,925.00

I recommend that Section "A," Sandy Road, be awarded to the Warren Construction Company, at the unit prices bid for Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling.....$198,690.90

I recommend that Section "B," Sandy Road, be awarded to the Warren Construction Company, at the unit prices bid for Asphaltic Concrete

No. 1 (*Bitulithic*) on an old macadam base, Totaling 16,159.17

TOTAL BID $214,850.07

BASE LINE ROAD, ESTIMATE $152,266.00

I recommend that Section "A," be awarded to the Clark-Henry Construction Company, at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling $132,493.20

I recommend that Section "B," Base Line Road, be awarded to the Clark-Henry Construction Company, at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling..... 15,886.20

TOTAL BID $148,379.40

FOSTER ROAD, ESTIMATE $76,303.00

I recommend that the Foster Road be awarded to Giebisch & Joplin, at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling..... $70,976.95

POWELL VALLEY ROAD, ESTIMATE $128,935.00

I recommend that the Powell Valley Road be awarded to Oskar Huber at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling..... 121,603.90

CAPITOL HIGHWAY, ESTIMATE $95,814.00

I recommend that the Capitol Highway be awarded to Giebisch & Joplin, at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on an old macadam base, Totaling..... 89,988.74

CANYON ROAD, ESTIMATE $39,350.00

I recommend that Section "A," Canyon road, be awarded to Boyajohn-Arnold Hans Pederson, at the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed stone base, Totaling $16,903.60

I recommend that Section "B," Canyon Road, be awarded to Montague-O'Reilley Company, at the unit prices bid on *Cement Concrete* No. 1, inclusive of *Armor joints-Crushed stone aggregate,* Totaling..... 22,352.00

TOTAL BID $39,255.00

This recommendation is based on the fact that this section is on a 7½ per cent grade and there were no bids submitted on brick for this section which were low enough to come within the amount appropriated.

ST. HELENS ROAD, ESTIMATE $67,400.00

I recommend that Section "M," St. Helens Road be awarded to the Warren Construction Company, at

the unit prices bid on Asphaltic Concrete No. 1 (*Bitulithic*) on a crushed stone base, Totaling..... $28,537.03

I make no further recommendation on the St. Helens Road for the reason that other bids will exceed the estimate.

I would recommend that as soon as the final decision has been made on any section that the contract for the same be promptly awarded and not wait for a decision on all the roads, so that work can be immediately started as the season is getting short and the delay will prove expensive.

In conclusion I would recommend that an unquestionable and substantial maintenance guarantee be furnished by the successful bidder for the full ten years.

Due to the fact that the District Attorney's Office has continuously opposed the ten year maintenance guarantee, claiming that it could not be legally enforced, I would recommend that the greatest care be exercised by the Board in selecting the class of pavement that is beyond an experimental stage.

The eyes of the whole of Oregon are on Multnomah County and the example set will have great influence in the upbuilding of our State. A mistake of not selecting a proper pavement will handicap the progress of the good roads movement.

Respectfully submitted,

JOHN B. YEON,

Roadmaster.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 23.

THE BITULITHIC PAVEMENT
(Patented by)
WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

AGREEMENT

Boston, Mass., July 9th, 1917

To the Honorable State Highway Commission,
Salem, Oregon.

GENTLEMEN:—

Inasmuch as it is deemed advisable by the proper authorities that bids be received for the improvement of the WEST SIDE PORTION OF THE PACIFIC HIGHWAY FROM THE MULTNOMAH COUNTY LINE TO NEWBERG, APPROXIMATELY 15 MILES IN LENGTH—in the STATE OF OREGON with THE BITULITHIC PAVEMENT; and inasmuch as the construction of said pavement requires the use of certain patented processes and compounds; and inasmuch as competitive bidding in the letting of contracts for road improvements is deemed advisable, in order to provide for such competitive bidding, and at the same time secure the adoption of THE BITULITHIC PAVEMENT as the kind of pavement to be constructed in the above-named road the under-

signed, Warren Brothers Company, as owner of all patents and processes covering the laying of said BITULITHIC PAVEMENT, hereby proposes and agrees, for the consideration hereinafter named, with the STATE HIGHWAY COMMISSION or with any bidder, to whom a contract may be awarded to pave the above-named road with THE BITULITHIC PAVEMENT, at any time within six (6) months from this date, and who shall enter into a contract with such surety or sureties as may be required by said STATE HIGHWAY COMMISSION to furnish, for the performing of any such contract and for making any repairs which may become necessary during the period of any maintenance guarantee provided for in such contract, the following materials ready for use, service and use of machines, coupled with a free license to use any or all the patents, trade-marks, or trade names now owned or which may hereafter be owned by Warren Brothers Company, necessary to lay said pavement:—

1. The necessary roadway mixture for the wearing surface having a thickness of two (2) inches after compression prepared under the patented process of Warren Brothers Company, and delivered hot in the wagons of the Commission Contractor at the BITULITHIC mixing plant located in within three (3) miles of the work to be performed.

2. The right to use any and all patents, trade-marks or trade names now owned or which may hereafter be owned or controlled by Warren

Brothers Company, which are necessary to be used in the laying of such pavement.

3. The seal coat materials necessary for coating the wearing surface, delivered on wagons of the Commission or Contractor at the BITULITHIC mixing plant located as above.

4. The license to use the patented flushcoat bitumen and stone spreading machines, which machines will be furnished by Warren Brothers Company.

5. An expert, who will give proper advice as to the building of such pavement, will be furnished to the Commission or Contractor at the expense of Warren Brothers Company.

6. Two daily examinations of the mixture as delivered on the road will be made at the Laboratory of Warren Brothers Company, to determine if uniformity has been accomplished in the mixture and construction; said samples to be sent, prepaid, to the Laboratory of Warren Brothers Company, Potter Street, East Cambridge, Mass., or 289 East Salmon Street, Portland, Ore., by the Commission or Contractor.

The price at which this service is offered to any and all contractors who make a bid on THE BITULITHIC PAVEMENT, for said road is ninety-four cents ($.94) per square yard of finished pavement, at which price it is also agreed to furnish the materials in barrels for reheating, and the service for making all repairs, if any, which may be necessary for the wearing surface during the life of said patents.

The acceptance of bids by your Commission and

the letting of a contract for the same shall be deemed by Warren Brothers Company to be an acceptance of the proposal by the Commission and by the Contractor to whom such contract shall be awarded, and are all that shall be necessary to bind Warren Brothers Company to this agreement.

This agreement is executed in accordance with the By-Laws of Warren Brothers Company, authority to execute such agreement under said By-Laws being granted to any two of the following officers, viz.: the President, any one of the Vice-Presidents, the Treasurer, the Assistant Treasurer, the General Manager, and the Secretary.

WARREN BROTHERS COMPANY
By W. B. WARREN,
And HERBERT M. WARREN.

[Stamped]: IT IS FURTHER UNDERSTOOD AND AGREED that WARREN BROTHERS COMPANY shall not be required to commence or proceed with said work and shall be allowed reasonable extension of time to complete the same, if they by the exercise of due diligence are unable to obtain materials and labor necessary for the prosecution of this contract by reason of railroad embargoes, governmental requisition of railroads and other war measures or by reason of fire, flood, the common enemy or other cause outside the control of WARREN BROTHERS COMPANY.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 24.

THE BITULITHIC PAVEMENT

(Patented by)

WARREN BROTHERS COMPANY

LICENSE AGREEMENT

Boston, Mass. July 9th 1, 1917.

To the Honorable State Highway Commission,
Salem, Oregon.

Gentlemen:

INASMUCH as it is deemed advisable by the proper authorities of the STATE HIGHWAY COMMISSION, State of OREGON, that bids be received for the improvement of the WEST SIDE PORTION OF THE PACIFIC HIGHWAY FROM THE MULTNOMAH COUNTY LINE TO NEWBERG, APPROXIMATELY 15 MILES IN LENGTH with THE BITULITHIC PAVEMENT under and in accordance with the specifications of the STATE HIGHWAY COMMISSION, and

INASMUCH as the said improvement contemplated requires the laying of a certain patented pavement wearing surface, and as competitive bidding in the letting of contracts for the said improvement is deemed advisable, and

WHEREAS, Warren Brothers Company is unwilling to allow said pavement or roadway, which involves the use of patents and processes owned and controlled by it, to be used unless the BITU-

LITHIC CEMENT specified in the specifications be used;

NOW, THEREFORE, in order to provide for such competitive bidding and at the same time assure the adoption of the said BITULITHIC as the kind of pavement or roadway to be constructed on said road the undersigned Warren Bros. Co., a corporation, as owner of patents and processes covering the said BITULITHIC PAVEMENT, and the laying and construction thereof, for the consideration hereafter named, hereby proposes and agrees to grant to the STATE HIGHWAY COMMISSION and to any bidder to whom a contract may be awarded, and who shall enter into a contract with the STATE HIGHWAY COMMISSION six months from the date hereof, or at any time thereafter until this proposition is formally withdrawn, the right and license to use any and all patents and processes owned and controlled by Warren Brothers Company, which are necessary to be used in the laying of said BITULITHIC PAVEMENT and the perpetual right to use the patented pavement or roadway so constructed, and to furnish the following as specified in and required under and by said specifications:

1. The necessary suitable paving plant, f. o. b. cars at nearest railway station to the proposed work or roadway; said plant to be kept in repair by the STATE HIGHWAY COMMISSION or contractor and to be reloaded on cars on completion of the work in as good condition as when received, ordinary wear and tear excepted.

2. The necessary special street tools (not including shovels, picks, wheelbarrows, etc.) as follows: Flushcoat spreading machine, fire wagon, tampers and street kettle.

3. The necessary BITULITHIC CEMENT, including the BITULITHIC CEMENT for the surface finish or seal coat course for a pavement or roadway constructed under the said specifications; said material to be delivered f. o. b. cars at the nearest railway station to the proposed work or roadway.

4. We will make daily examination at our laboratory of the mixture as delivered on the street or roadway to see that uniformity has been accomplished in the mixture and construction.

5. We will also furnish the successful bidder expert advice in connection with the BITULITHIC PAVEMENT and the contractor bidding under this agreement hereby binds himself to at all times comply with such advice or inspection on the part of Warren Brothers Company's inspectors as to the mixing, selecting and combining of materials entering into the wearing surface, and the spreading and compressing of same, and in the application of the surface finish or seal coat.

6. The price at which said material and the right and license to use said patents and processes is offered to the STATE HIGHWAY COMMISSION and to all contractors who may bid on the BITULITHIC PAVEMENT is sixty (60) cents ($.60) per square yard of finished pavement laid to a thickness of two (2) inches after thorough

compression, which shall include the right and license to use all patents and processes necessary to be used in the laying of said BITULITHIC PAVEMENT street or road, owned and controlled by Warren Brothers Company, and the perpetual right to use the patented roadway so constructed and all the BITULITHIC CEMENT necessary for the construction of the BITULITHIC pavement.

7. If the contractor has a plant suitably equipped to manufacture the BITULITHIC surface mixture, and desires to use said plant and special street tools as covered by paragraphs 1 and 2 above, then Warren Brothers Company hereby agrees to make a reduction of seven (7) cents per square yard in license agreement as above set forth, provided the suitability of such plant and special equipment is passed on by the engineer in charge of the work, said engineer to give Warren Brothers Company an opportunity to submit to him their opinion regarding the suitability of said plant before passing on same.

8. If the contractor lays the surface thicker than the two (2) inches covered by this license, or if it becomes necessary for him to relay any surface, due to faulty foundation or contour or otherwise, then Warren Brothers Company shall be reimbursed for all BITULITHIC CEMENT so used in excess of what is required in said two (2) inches.

The procuring of said BITULITHIC CEMENT from Warren Brothers Company and the exclusive use thereof in the construction of said improvement,

and the construction of the said BITULITHIC pavement in accordance with the license agreement will release the STATE HIGHWAY COMMISSION and the officials thereof, as well as the contractor, from any and all claims for royalty arising or to arise by reason of the construction of said proposed street or roadway.

The execution of the contract for the said work by the successful bidder and the authorities of said STATE HIGHWAY COMMISSION as required by law, shall bind the undersigned Warren Brothers Company to furnish the material and grant the license herein referred to to the contractor at the price herein offered.

The word "contractor," as used herein, shall be deemed to include not only such successful bidder with whom such contract may be made and entered into, but also the said STATE HIGHWAY COMMISSION if it shall elect to itself make or lay such BITULITHIC pavement.

Respectfully submitted,
WARREN BROTHERS COMPANY,
By W. B. WARREN,
Vice-President.

Attest—A. J. HILL.

[Stamped]: IT IS FURTHER UNDERSTOOD AND AGREED that WARREN BROTHERS COMPANY shall not be required to commence or proceed with said work and shall be allowed a reasonable extension of time to complete the same, if they by the exercise of due diligence are unable to obtain materials and labor necessary for the

prosecution of this contract by reason of railroad embargoes, governmental requisition of railroads and other war measures or by reason of fire, flood, the common enemy or other cause outside the control of WARREN BROTHERS COMPANY.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 25.

THE BITULITHIC ROAD
(Patented by)
WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS
AGREEMENT

Boston, Mass., May 24th, 1915

To The Honorable County Commissioners of Multnomah County, Oregon.

GENTLEMEN:—

Inasmuch as it is deemed advisable by the proper authorities of County of Multnomah, State of Oregon that bids be received for the improvement of Columbia River Highway, designated by the County Commissioners as Section "E" with the BITULITHIC; and inasmuch as the construction of the said road requires the use of certain patented processes and compounds; and inasmuch as competitive bidding in the letting of contracts for such improvement is deemed advisable, in order to provide for such competitive bidding, the under-

signed, Warren Brothers Company, as owners of all patents and processes covering the laying of said BITULITHIC, hereby proposes and agrees for the consideration hereinafter named, to furnish to the County of Multnomah or to any bidder to whom a contract may be awarded to improve said Road with the BITULITHIC within one (1) year from this date, and who shall enter into a contract with such surety or sureties as may be required by said County of Multnomah all of the materials required for the construction of the wearing surface two (2) inches in thickness after compression and surface finish course, as follows:—

The wearing surface mixture prepared under the patents of Warren Brothers Company.

The flushcoat composition, together with the use of flushcoat spreading machines for spreading the flushcoat composition and the sand, gravel or stone screenings for the surface finish course.

All of said materials to be delivered to the contractor at plant erected within four (4) miles of the place where the said materials are to be used, for the sum of ninety-eight (98) cents per sq. yd. of finished pavement for such materials furnished; said price including the right to use the patents referred to.

The acceptance of bids by the County of Multnomah and the letting of a contract for the same shall be deemed by Warren Brothers Company to be an acceptance of this proposal by the County of Multnomah and by the Contractor to whom such contract shall be awarded, and are all that shall

be necessary to bind Warren Brothers Company to this agreement.

Respectfully submitted,
WARREN BROTHERS COMPANY,
By W. B. WARREN,
And ALBERT C. WARREN,
Secretary.

I, Ralph L. Warren, General Manager, of WARREN BROTHERS COMPANY, hereby certify that under the by-laws of said Company, authority to execute this agreement is granted to any two of the following officers of the Company, viz.:—the President, any one of the Vice-Presidents, the Treasurer, the Assistant Treasurer, the General Manager and the Secretary; and that this agreement is executed by the proper officers of said Company by virtue of said authority.

Witness my signature and the seal of the Company this 24th day of May, 1915.

RALPH L. WARREN,
General Manager.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 29.

(COPY)

BLOCK No. 99, EAST DENVER, BETWEEN ARAPAHOE AND CURTIS, AND 14TH AND 15TH STREETS.

BLAKE PAVING CO.

PERMIT NO. 7284—ISSUED JULY 11, 1892.

State of Colorado,
City and County of Denver.—

Agnes M. Robertson, 624 West Colfax Avenue, Denver, Colorado, being first duly sworn, upon oath, deposes and says: That the following is a true and correct copy of the AGREEMENT AND SPECIFICATIONS under which THE BLAKE ASPHALT COMPANY constructed the paving in the alley lying between Arapahoe, Curtis, 14th and 15th streets in the City of Denver, under Permit No. 7284 issued by the City of Denver on the 11th day of July 1892.

AGNES ROBERTSON.

Subscribed and sworn to before me this 10th day of July, 1915.

My commission expires April 12, 1915.

[Seal] FRANK J. EMPEROR,
Notary Public.

(COPY)

THIS AGREEMENT, made and entered into this 8th day of July, A. D. 1892 by and between the subscribers to this instrument hereinafter named,

of the first part and THE BLAKE ASPHALT COMPANY, a Corporation, of the second part,

WITNESSETH:

THAT THE BLAKE ASPHALT COMPANY hereby agree to make all necessary excavations to grade and subgrade, furnish all necessary materials and labor, and therewith construct an asphalt pavement, in accordance with plans and specifications hereto attached and made a part of this contract, under the direction and to the satisfaction of the city engineer of the city of Denver, in the Alley upon which the lots described and set opposite the subscribers' names, abut, in the East division of the city of Denver, hereby agreeing and guaranteeing to maintain said pavement in good repair for the period of five years from and after the completion of the same, without further cost or expense to the subscribers. The cost of construction, maintenance, and repair, to be paid for by the parties of the first part at the rate of two and 40/100 dollars per foot of the frontage of the several lots of the subscribers, abutting upon said alley.

This agreement shall be binding upon said company, when, but not until all of the said frontage shall have been subscribed for by parties of known responsibility.

The said THE BLAKE ASPHALT COMPANY agrees to begin said work within 60 days after all of said frontage has been subscribed for, and prosecute the same without delay and with reasonable diligence until completed.

IN CONSIDERATION WHEREOF, the subscribers hereto, parties of the first part, respectively agree, that they are the owners of the several lots and parcels of land described opposite their respective names, and that they will respectively pay THE BLAKE ASPHALT COMPANY the several sums set opposite their respective names, as and for their respective shares of the cost of said improvement, the same to be paid in cash upon the original completion of said pavement; the amount due for such improvement to be a lien on their respective premises until paid, and it is mutually agreed that the obligation created by this instrument shall be several and not joint.

And the subscribers hereto, parties of the first part, and each of them, hereby authorized the said THE BLAKE ASPHALT COMPANY to make application in our names for the necessary permit or permits for grading and paving said alley; and we hereby authorize the said THE BLAKE ASPHALT COMPANY to act as the attorney in fact for all and each of us in signing any or all of our names to any and all petitions necessary or proper or required to be made in petitioning for paving or other improvements under the ordinances of the city of Denver or the laws of the state of Colorado.

IN WITNESS WHEREOF THE BLAKE ASPHALT COMPANY, party of the second part, has caused these presents to be signed by its Manager this 8th day of July, A. D. 1892, and the parties of

the first part, subscribers hereto, have hereunto set their hands on the several dates set opposite their respective names.

THE BLAKE ASPHALT COMPANY.

(Sgd.) By F. O. BLAKE,

Mgr.

DATE	SUBSCRIBERS	LOT	BLOCK	FRONTAGE	AMOUNT.
Signed	The Colorado Mining Stock Exc.	1, 2, 3, 4,	99		100
"	The Colorado News Co.	5	"		25
"	Estella Hoyt	7, 8,	"		50
"	The Jefferson Investment Co.	10, 11, 12	"		75
"	The Colorado Seminary	½ 14, 15, 16	"		62½
"	Robert McElvanney	13½ of 14	"		37½
"	Lester Babcock	17 and 18	"		50
"	Estate Frank A. Howard	19, 20½, 21	"		62½
"	Oscar R. Young	½ of 21 and 22	"		37½
"	C. J. Reilly	23			25
"	Fannie J. Gothe	24			
"	William Malonies	9			25
"	Chas. Wheeler	25, 26			50
"	Mary Cella	27, 28			50
"	Hughes Estate	29, 30, 31 and 32			100

SPECIFICATIONS FOR PAVING DONE BY THE BLAKE ASPHALT COMPANY.

FIRST: Alleys shall have asphalt topping 1½″ thick when compressed, with base of asphaltic concrete 4½″ thick, the whole forming one solid mass 6″ thick.

SECOND: The space over which the paving is to be laid shall be excavated to a depth of 6″ below the proposed surface line of the pavement. All objectionable or unsuitable material below subgrade shall be removed and the space filled to subgrade with clean sand and gravel. The subgrade after having been perfectly puddled by the use of water through hose or other necessary appliances shall be trimmed and then thoroughly rolled with a steam roller weighing not less than five tons and shall then be retrimmed; the rolling and trimming to be continued until the subgrade is completed in a thorough and workmanlike manner, or to the satisfaction of the city engineer. All soft places that cannot be reached by the roller, shall be dug out and refilled in layers and hand tamped or puddled or both, as may be necessary, or directed by the city engineer.

All excavated materials shall be removed at once from the work and deposited by the contractor at points to be designated by the city engineer.

THIRD: Upon the bed thus prepared and brought to sub-grade will be laid a base of asphaltic concrete composed as follows:

Asphalt 8 per cent to 10 per cent; sand and gravel 90 per cent to 92 per cent, the whole to be thoroughly

mixed while hot and tamped or rolled to a true surface and must be 1½′ below the finished surface of the ——.

FOURTH: The wearing surface or topping will be composed of asphalt cement 15% to 20%.

Clear sharp sand, 65% to 70%.

Powdered carbonate of lime 10% to 15%.

The asphalt must be equal at least to Trinidad Asphalt and unmixed with the products of coal tar, and may be reduced with a sufficient quantity of residuum not to exceed 15%.

The sand and asphalt are to be heated separately to about 300 deg. F.

The carbonate or sulphate of lime while cold must be mixed with the hot sand, and the asphalt cement added to the mixture, and the whole now well and thoroughly mixed and brought on the ground at not less than 240 deg. F., and spread compressed and smoothed by rollers or smoothing irons to the true surface of the established grade.

Denver, Colorado, April 10, 1915.

Received from WARREN BROS. CO. $7.00 for copying this agreement and specifications.

AGNES M. ROBERTSON.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 30.

HAMILTON CITY CORPORATION.
BOARD OF WORKS DEPARTMENT.

Specifications for Tar Macadam Roadways.

EXCAVATION.

All earth or other material above the sub-grade shall be excavated, so as to conform to the level of the sub-grade, which will be ten inches below the finished surface of the roadway; and should the sub-grade be above the level of the natural ground, then earth shall be deposited until the level of the sub-grade is reached. The sub-grade shall be shaped to the profile and cross section which will be furnished by the City Engineer.

ROLLING.

After the sub-grade has been formed to the proper camber of the road, generally ½ inch per foot or 6 inches for 24 foot roadway, to be thoroughly rolled with the steam road roller, and if by this means soft spots are revealed, they shall be filled with good solid material.

SIZE OF STONE.

The first six inches shall be made in the ordinary way for a Macadam or Telford roadway thoroughly rolled. If so required, it may be made of hard broken stone, furnace clinkers, or brick rolled smooth and finished to the required camber of the road. Upon this shall be placed the tarred stone. The first layer—three inches of hand broken stone to pass through a 2½ inch ring, then a two inch

layer of machine broken stone, the whole smoothed off with a hand roller and after top dressing is applied thoroughly rolled with a steam roller. On this a layer composed of fine gravel and quarry chippings, mixed in equal proportions, three-quarter inches thick, shall be placed, and well rolled in so as to fill all interstices. Before finishing, a dressing of stone screenings for the purpose of coloring shall be scattered broadcast to be worked in by the traffic. All layers, including the coloring layer, shall be thoroughly compacted by rolling.

METHOD OF MIXING TAR.

The stone to be tarred shall if moist be heated on an iron floor, under which are flues from a fire, until the moisture is driven out. The material in its heated state is then to be thoroughly mixed with a sufficient quantity of tar. The broken stone in warm weather may be sun dried but in all cases the finer course must be artificially dried. At the same time care must also be taken not to get this material too hot. The tar should be boiled in iron kettles holding one hundred imperial gallons. Eight imperial gallons should be added to each cubic yard of the coarser material or more if required to completely cover the stone, and seventeen to eighteen gallons to the finer kinds of stone.

TAR.

The tar must be pure Coal Tar free from all foreign substances and containing not more than 5 per cent of water and shall contain upon analysis not less than 55 per cent pitch.

WEATHER.

The work must be done in the summer months, and all work must be suspended during wet weather.

E. B. WINGATE,
City Engineer.

City Engineer's Office, Hamilton, August, 1900.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk. No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 31.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk. No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

ADVERTISEMENT

Which is to be Included and Considered as Part of this

CONTRACT.

DEPARTMENT OF PUBLIC WORKS.

1893.

TO CONTRACTORS.

SEALED PROPOSALS for the improvement of North Highland Avenue from Bryant Street northerly, will be received at the office of the City Controller until the 27th day of May, at 2 o'clock, P. M.

a. The City of Pittsburgh reserves the right to reject any or all bids, should they deem it for the interest of the City.

b. No contract shall be awarded to any person in arrears to the City, from any cause; or who may have, in former contracts with the City, failed to perform work satisfactory, either in the character of the work or the time unnecessarily consumed in its completion by neglect or wilful delay.

c. The estimated quantities for paving, curbing and otherwise improving North Highland Avenue as shown on Letting Plan, No. 189, are to be considered and taken as APPROXIMATE, and the right is expressly reserved by the party of the first part to this agreement, to increase or diminish the said quantities. Nor shall any change of grade, alignment, or otherwise vitiate, annul or impair the contract made and entered into relative to said work, nor constitute any claim for compensation on account of prospective profits. The contractor shall be paid for the amount of work actually performed, at the rates specified in the proposal therefor, and annexed to this contract as part thereof. The full measure of compensation to the contractor to be determined by the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, whose final estimate of said work shall be conclusive evidence thereof, and of binding force.

d. The prices bid are to cover the furnishing of all materials entering into the construction of the work, and the necessary labor and tools required to

perform the work in strict accordance with the plans and specifications of said work.

e. Bidders will be required to accompany their proposals with a "Bond" for one-half the estimated cost of the work, including all material duly and legally executed by the party or parties making the proposals, with two freeholders of the County of Allegheny as sureties thereon, each of whom shall certify before the Mayor or City Clerk that he is or they are worth over all encumbrances the full amount of the proposed bond, and such bond before such contract shall be binding upon the City shall first have been approved by Councils, and which bond shall be held as security for the payment of any difference between the sum to which the contractor would be entitled to on the completion of the work at the price stated in the proposal, and that which the City of Pittsburgh may be obliged to pay to any higher bidder at any subsequent letting should he or they refuse to sign the agreement or perform the work satisfactory in accordance with the plans and specifications relating to and regulating the same. With the further conditions that the said City of Pittsburgh shall be indemnified against all loss, costs and damages which may arise from the non-fulfillment of this contract in any manner whatever, or for or by reason of any failure of any kind whatsoever upon the part of the said contractor to perform fully and faithfully all the terms and conditions therein named and contained.

f. The party or parties to whom the contract shall be awarded will be required to attend at this

office within five (5) days from the date of award to sign the agreement, and in case of failure or neglect so to do, he or they will be considered as having abandoned it, and as in default to the said City; and thereupon the Chief of Department of Public Works may re-advertise said work to be re-let as before, and so on, until the contract be accepted and agreement executed.

g. In no case will contractors be allowed to use materials other than of the quality and dimensions prescribed in the plans and specifications, or which may be specified by the Superintendent of Engineering and Surveys.

h. Bidders will examine for themselves the location of the proposed work, so that no misunderstanding may exist in regard to the nature of the work to be done.

i. Bidders will be furnished with blanks at this office and none other will be accepted.

N. B.—Bidders are particularly notified, that a provision in the contract requires the contractor to keep continuous in repair the said work or improvement for the full period of 5 years after the completion and acceptance of the same at the expense of said contractor. In all cases where stone masonry is required, the same shall be paid for at a price per cubic yard, the number of yards to be ascertained and determined by the actual cubical contents thereof, without any allowance on account of face measurement.

FORM OF AGREEMENT,

To be Executed for the Improvement of North Highland Ave., from Bryant Street northwardly.

Made and concluded this 15th day of July, A. D. 1893, by and between the City of Pittsburgh, through the Chief of Department of Public Works, duly authorized thereto by an ordinance of the Councils of said City, approved 22d day of April, A. D. 1893, party of the first part, and Booth & Flinn Ltd. of Pittsburgh, Pa., Contractor, parties of the second part.

WITNESSETH, That the said parties of the second part have agreed, and by these presents do agree with the said party of the first part, for the consideration hereinafter contained, and under the conditions set forth in a "bond" bearing date May 25, 1893, and hereunto annexed and made part thereof to furnish, at their own proper cost and expense, all the necessary materials, labor and tools, to repave and curb, in a good and substantial manner N. Highland Ave. from Bryant St. northwardly under conditions and in compliance with the following

SPECIFICATIONS.

Grading.

Materials, how paid for.

1. To include all materials on the street, both on roadways and sidewalks. All surplus material to be deposited as the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys may direct. The contractor not to be paid for both excavating and

filling, but for whichever contains the greater number of cubic yards. All the materials furnished and all the work done, which, in the opinion of the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, shall not be in accordance with this specification, shall be immediately removed, and other materials furnished and work done, which shall be in accordance therewith.

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2. The work under this agreement is to be prosecuted at and from as many different points in such part or parts of the street, on the line of the work, as the said Superintendent of Engineering and Surveys may from time to time direct.

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3. The right to construct any sewer or sewers, or receiving basins and culverts, or build up or adjust any manholes, or to re-set or renew any frames and heads for sewer manholes in said street, and to grant permits for house connections with sewers, or with water or gas pipes, at any time prior to the laying of the new pavement over the line of the same, is expressly reserved by the said Superintendent (and he expressly reserves the right of suspending the work or any portion thereof, on any part of said line of street or streets, at any time during the construction of the same for the purpose above stated, or for any other purpose, without other compensation to the contractor for such suspension, than extending the time for completing the work so long as it may have been delayed by such suspension); and said contractor shall not interfere with, or place any

impediments in the way of any persons or persons who may be engaged in the construction of such sewer or sewers, or in making connections therewith, or doing other work above specified, or in the construction of any receiving basins and culverts, or in setting or re-setting any curb or gutter stones on the line of the street, or in the performance of any other work deemed necessary by the Superintendent of Engineering and Surveys.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENTS.

No. 1.

Preparation of Foundation.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such materials shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any directions nor less than two (2) inches (the stone to be Ligonier or Granite spalls or of hard native stone). This

layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Upon this road-bed so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled poured with hot composition distilled expressly for the purpose, using not less than one gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition well heated and thoroughly mixed through steam mixers shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and Heavy Petroleum Oil, unmixed with any of the products of Coal Tar.

The Asphaltic cement shall be prepared in the following proportions:

Refined Asphaltum,	100 parts.
Heavy Petroleum Residuum,	20 "

The wearing surface shall be composed of:

Asphaltic Cement	from	12	to	16	parts.
Sand,	"	73	"	67	"
Pulverized Carbonate of Lime,	"	15	"	17	"

These portions will be varied according to circumstances, as may be necessary to secure the best practical result.

The Sand and Asphaltic Cement are to be heated separately to about 300 deg. Fahr. The pulverized Carbonate of Lime, when cold, will be mixed with the hot sand in the required proportions, and will then be mixed with the Asphaltic Cement at the required temperature in the proper proportion, in an apparatus suited to effect a perfect mixture.

The pavement mixture thus prepared will be brought to the ground in carts, at a temperature of about 250 deg. Fahr., it will then be carefully spread by means of iron rakes, in such a manner as to give a uniform and regular grade, and to such depth that, after having received its ultimate compression, it will have a thickness of two (2) inches. The surface will then be compressed by a hand roller, after which a small amount of hydraulic cement will be swept over it, and it will then be thoroughly compressed by a steam roller, the rolling being continued as long as it makes an impression on the surface.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT.

No. 2.

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All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the subsoil or other matter (be it earth, rock, or other material), shall then be excavated and removed to a depth of nine (9) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand, and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction, nor less than two (2) inches (the stone to be Ligonier, granite, spalls or of hard native stone). This layer shall be compactly rolled, to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight; poured with hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard so as to thoroughly permeate all crevices, or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated

through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixers, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and Heavy Petroleum Oil, unmixed with any of the products of Coal Tar.

The Asphaltic cement shall be prepared in the following proportions:

Refined Asphaltum,	100 parts.
Heavy Petroleum Residuum,	20 "

The wearing surface shall be composed of:

Asphaltic Cement,	from 12 to 16 parts.
Sand,	" 73 " 67 "
Pulverized Carbonate of Lime,	" 15 " 17 "

These portions will be varied according to circumstances, as may be necessary to secure the best practical result.

The Sand and Asphaltic Cement are to be heated separately to about 300 deg. Fahr. The pulverized Carbonate of Lime, when cold, will be mixed with the hot sand in the required proportions, and will then be mixed with the Asphaltic cement at the required temperature in the proper proportions, in an apparatus suited to effect a perfect mixture.

The pavement mixture thus prepared will be brought to the ground in carts, at a temperature of about 250 deg. Fahr., it will then be carefully spread by means of iron rakes, in such a manner as to give a uniform and regular grade, and to such depth that, after having received its ultimate compression, it will have a thickness of one and one-half (1½) inches. The surface will then be compressed by a hand roller, after which a small amount of hydraulic cement will be swept over it, and it will then be thoroughly compressed by a steam roller, the rolling being continued as long as it makes an impression on the surface.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT.

No. 3.

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ndation.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled,

said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys, with a steam roller of not less than ten (10) tons weight. Upon this road-bed so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled, poured with hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixers, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt,	from 28 to 43 parts.
No. 4 Pitch,	" 72 " 57 "

The wearing surface shall be composed of:

Asphalt Cement,	from 14 to 18 parts.
Crushed Ligonier Stone,	" 43 " 41 "
Sharp River Sand,	" 43 " 41 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with a steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENTS.

No. 4.

Preparation of foundation. All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of nine (9) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10)

tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be Ligonier, Granite spalls, or of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Upon this road-bed when rolled there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition well heated and thoroughly mixed through steam mixers shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt,	from	28	to	43	parts.
No. 4, Pitch,	"	72	"	57	"

The wearing surface shall be composed of:

Asphalt Cement,	from	14	to	18	parts.
Crushed Ligonier Stone,	"	43	"	41	"
Sharp River Sand,	"	43	"	41	"

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass.

CURBING.

Quality and Size.

The stone to be used for curbing shall be first quality Beaver, Baden or Freeport stone, or equal in quality, free from all defects whatsoever; no stone shall, when dressed, be less than four (4) feet in length (except for closure) and two (2) feet in depth.

No stone shall be less in length on the bottom than on the top, all joints shall be full depth of the stone truly squared so as to make close joints, they shall be smoothly dressed on top for the width of six (6) inches, which width shall be uniform for all stone, three (3) inches on the side next the foot-walk and dressed twelve (12) inches

deep in front; no stone shall be less than six (6) inches in thickness in any part; corner stone shall be cut to a radius of three (3) feet, and in such manner as directed without extra charge.

All to be set true to line and grade. Before any curbstones are set the contractor shall excavate a trench to the depth of three (3) feet below grade line, and twelve (12) inches wide, in which shall be placed and rammed twelve (12) inches in depth of broken stone, slag or such other material as the Superintendent of Engineering and Surveys shall approve, then the curbstones set thereon; in case of embankments or fills no broken stone shall be placed under the curb unless otherwise ordered by said Superintendent of Engineering and Surveys. Broken stone, slag or other material shall be rammed behind the stone to the thickness of six (6) inches, and to the full depth of the stone. The earth, when no stone or slag is required, shall be thoroughly rammed, made perfectly compact and solid before setting the curb; any stone condemned by the said Superintendent of Engineering and Surveys shall be immediately removed from the street or line of improvement.

At each end of any embankment or fill, cross-drains shall be dug from the bottom of the curbstone to any drop, manhole or water-course, without extra charge.

REPAVING.

How done. 16. Whenever a street is to be repaved, the curbstone shall be reset at the price named in the contract; if new curbstones are necessary, the con-

tractor shall furnish them of the standard quality, size and form, to be paid for at the rate agreed upon on said contract. Any material reserved by the Superintendent of Engineering and Surveys shall be placed where he shall direct, without any extra charge therefor.

GENERAL REQUIREMENTS.

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All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work, the sub-soil or other matter, (be it earth, rock, or other material), shall then be excavated and removed to the depth of sixteen and one-half (16½) inches for No. 1 and nine (9) inches for No. 2, below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed and the spaces filled with clean gravel, sand or cinder, carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid.

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The contractor will be required immediately upon the completion of the grading and setting of curbstones, to notify the Superintendent of engineering and surveys when he shall proceed to examine whether the street has the required depth for the reception of the stones; and in no case shall any stones be hauled on the street before such examination shall have been made and the contractor notified to proceed with the work by the Superintendent of Engineering and Surveys.

Similar notice shall be given by the contractor after the completion of the paving.

Damages to be sustained by Contractor.

It is hereby further agreed that all loss or damage arising out of the nature of the work to be done under this agreement, or from any unforeseen obstructions or difficulties which may be encountered in the prosecution of the same, or from the action of the elements, or from any encumbrances on the line of the work, shall be sustained by the contractor.

Meaning of Terms.

Wherever the word "contractor," or the words "party of the second part," or the pronouns in place thereof, are used in this contract, they are to be considered as referring to and meaning party or parties, as the case may be, of the second part to this agreement.

Provisions of Contract.

In all matters not herein specified, this contract shall be subject to the provisions of the Acts of Assembly of the Commonwealth of Pennsylvania, and the Ordinances of the City of Pittsburgh now in force, so far as they are applicable thereto.

Stakes to be preserved.

The contractor shall be required to preserve all stakes that may be set by the Superintendent of Engineering and Surveys on the line of the work, defining grade, curb or street lines; and if he fails so to do, he shall be charged for all the time and expense that may be necessary to replace them by the Superintendent of Engineering and Surveys; he shall also be required to preserve all monuments that may have been placed upon the line of the street, defining its boundaries, and shall in no case be permitted to interfere therewith; and if, in the prosecution of the work, it may be found necessary to remove any such monuments, he shall immedi-

ately inform the Superintendent of Engineering and Surveys of the fact, and the Superintendent of Engineering and Surveys shall attend to the removal thereof. The Superintendent of Engineering and Surveys shall notify the contractor of the location of all such monuments along the line of the work, with instructions to him as to how he may proceed in the locality where such monuments are placed, which instructions are to be faithfully carried out; and if violated by the contractor, or his agents, he shall be liable to pay for all the time and expense that may be incurred in replacing any and all such monuments so moved or misplaced.

Attention to be given to work by Contractor.

The said party of the second part hereby further agrees, that he will commence the work aforesaid on such day, and at such point or points, as the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys may designate, and fully complete the same, in accordance with this agreement, on or before the expiration of days next thereafter, except the time may be extended by the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys; that he will give his personal attention properly to the faithful prosecution of the said work; that he will not sub-let the aforesaid work, but will keep the same under his own control. If at any time any overseer or workman employed by the contractor shall be declared by the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, to be unfaithful

or incompetent, the contractor on receiving notice shall forthwith dismiss such person, and no longer employ him on any part of the work.

Penalty for delay.

And the said party of the second part hereby further agrees, that the said party of the first part shall be, and is hereby authorized to deduct and retain out of the moneys which may be due or become due to the said party of the second part under this agreement, as liquidated damages for the non-completion of the work within the time hereinbefore mentioned for its completion, the sum of fifty (50) dollars for each and every day the completion of the work is delayed beyond the time hereinbefore stipulated for the completion of the whole of the work under this agreement.

Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys authorized to employ men, if necessary.

The said party of the second part further agrees, that if, at any time the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys shall be of opinion that the said work or any part thereof is unnecessarily delayed, or that the said contractor is willfully violating any of the conditions or covenants of this agreement or is executing the same in bad faith, he shall have power to notify the aforesaid contractor to discontinue all work under this contract, or any part thereof; and thereupon the said contractor shall cease said work, or such part thereof and the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys shall thereupon have the power to place such and as many persons as he or they may deem necessary, by contract or otherwise, to work

at and complete the work herein described, or any part thereof and to use such materials as he may find upon the line of said work, or to procure other materials for the completion of the same, and to charge the expense of said labor and materials to the aforesaid contractor; and the expense so charged shall be deducted from and paid by the party of the first part out of such moneys as may then be due, or may at any time thereafter become due to the said contractor, under and by virtue of this agreement, or any part thereof; and in case such expense is less than the sum which would have been payable under this contract, if the same had been completed by him, he shall be entitled to receive the difference; and in case such expense shall exceed the last said sum, he shall pay the amount of such excess to the party of the first part on notice from the said Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys of the excess due.

Provision to keep and maintain said improvement in good repair.

And the said party of the second part hereby further agree for himself, his heirs, executors, administrators and assigns, that all said work or improvement shall be kept and maintained, at the expense of said contractor, in continuous good repair and condition for the period of five years from and after the completion and acceptance of said work. And it is further agreed, that if, at any time during the said period of five years from the date of the acceptance by said Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys of the work under this

agreement, the said work or any part or parts thereof (excepting only such part or parts of the work as after the completion thereof may have been disturbed in the construction or repairs of sewers or drains, or in laying or repairing of gas or water main and service pipes) shall, in the opinion of the said Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, require repair, and the said Superintendent of Engineering and Surveys shall notify the said party of the second part to make the repairs so required, the said party of the second part shall immediately commence and complete the same to the satisfaction of said Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys; and in case of failure or neglect on his or their part, within three days from the date of the service of the aforesaid notice to begin the same and faithfully prosecute the same to completion, the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys shall have the right to purchase such materials as he or they shall deem necessary, and to employe such person or persons as he or they may deem proper, and to undertake and complete the said repairs, and to charge the expense thereof to the said party of the second part as before mentioned.

Repairs to be made.

And the said party of the second part hereby further agrees to receive the following prices as full compensation for furnishing all the materials and labor, which may be required in the prosecution and

Compensation.

completion of the whole of the work to be done under this agreement, and in all respects completing the same to the satisfaction of the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, to wit:

For Grading, per cubic yard, the sum of.....$

1590 sq. yds. for Furnishing and Paving, Asphalt, #4, per square yard, the sum of $2.80

For Furnishing and Curbing, per lineal foot, the sum of .....$ 70¢

For resetting old Curbing, per lineal foot, the sum of .....$ 20¢

For repairing street returns, sq. yd, the sum of .....$ 30¢

as contained in the annexed Proposal:

Measurements, &c.

It being expressly understood and agreed by the parties hereto that the measurement shall be taken after the completion of the work, and the estimate and certificate of the Superintendent of Engineering and Surveys shall be final and conclusive evidence of the amount of work performed by the said contractor under and by virtue of this agreement, and shall be taken as the full measure of compensation to be received by the said contractor without the right of exception or appeal. And that the aforesaid prices cover the furnishing of all the different materials and labor, and the performance of all the work mentioned in this specification and agreement; and in case of any doubt or ambiguity touching any part of this contract or any of the plans or specifications referred to or connected therewith or any

other matter involved therein, the decision thereon by the said Chief of the Department of Public Works shall be deemed, taken and treated as final, binding, conclusive and obligatory upon all parties hereto without the right of exception or appeal.

Terms of Payment and Interest.

It being hereby understood and agreed that the ordinance of the City of Pittsburgh entitled "An ordinance relating to contracts between the City of Pittsburgh and contractors doing public work for the same, regulating the manner and time of payment of material and work done and furnished under such contracts," approved the 20th day of May, 1892, shall be deemed, taken and treated as part of this contract, to wit: in so far as it applies to the time and manner of payment and the interest thereon. The said ordinance reading as follows: "That in all contracts hereafter made between the City of Pittsburgh, and its contractors for the grading, paving and curbing of streets and the construction of sewers, there shall be inserted in such contracts by the Chief of the Department of Public Works, acting for and as the representative of said City, a clause or section as follows, viz.: In consideration of the faithful fulfillment of the contract by the said contractor or contractors as fully set forth and described in the specifications relating thereto, the said City of Pittsburgh shall pay or cause to be paid to the said contractor or contractors, his or their assigns, on estimates and certificates to be furnished by the Superintendent of Engineering and Surveys, approved by the Chief of the Department of Public Works, the full contract price there-

for out of and from the assessments which may from time to time be levied and collected from the properties benefited by the said improvement, as the same shall be ascertained and finally determined in the manner provided by law, and the ordinances of the said City of Pittsburgh relating thereto. That all the assessments shall be collected by the said City of Pittsburgh, or its authorized agents or officers within two years from and after the date of the completion and acceptance of said work. Said assessments when and as often as collected shall be paid by the said City of Pittsburgh upon proper warrants to said contractor or contractors, his or their assigns, as a credit upon the contract price in such contract named. The contractor or contractors, his or their assigns, shall be entitled to have and receive interest at the rate of six per cent. per annum upon all payments from and after the completion and acceptance of said work; provided, however, that the remainder of the assessments uncollected upon such contract with the interest thereon shall be payable by said City of Pittsburgh on and after the expiration of two years from the completion and acceptance of the work in such contract described. It is expressly agreed by the contractor or party of the first part hereto that this ordinance in all of its parts shall be deemed, taken and treated as part of this contract as though the same were inserted in all proposals, advertisements or bids.

The work shall be commenced on the day of and finished on or before 1st day of Oct., A. D. 1893.

The "Advertisement" hereto prefaced shall be considered as taken and included as part and parcel of this contract, and its provisions shall be of binding force.

IN WITNESS WHEREOF the Chief of the Department of Public Works, by virtue of the authority in him vested for that purpose, on behalf of the party of the first part, and the said parties of the second part, have hereunto set their hands and seals this 15th day of July, A. D. 1893.

Witness:

I. BINGAMAN.

E. M. BIGELOW. [Seal]
Chief Department of Public Works.

BOOTH & FLINN, LIMITED, [Seal]
WM. FLINN,
Chairman.

_____ [Seal]

_____ [Seal]

PROPOSAL
for the
Grading, Repaving and Curbing of N. Highland Ave. from Bryant St. northwardly.

Having examined the Plans and Specifications for the Grading, Paving and Curbing of the said street, in the office of Department of Public Works, and the agreement to be entered into in case of award of contract to us, we do hereby PROPOSE and AGREE to furnish all the Materials, Tools and Labor required to ~~grade,~~ repave and curb the above named N. Highland Ave. between the points men-

tioned in strict accordance with the Plans, Specifications and Instructions of the Chief of the Department of Public Works, or his assistant, the Superintendent of Engineering and Surveys, at the following prices:

Asphalt	~~for~~ ~~Grading,~~	the sum of	$325	per	Cubic	Yard.	No.	3
1590	" Paving, Asphalt		$280√	"	Square	"	"	4
1580	" " B. Stone		$300	"	"	"	"	1
	" " "		$335	"	"	"	"	2
	" " "		$	"	"	"		
	" Curbing, new		$0.70√	"	Lineal	Foot.		
	Ligonier							
790	" Crossing, Granite		$0.70√	"	Square	"		
	~~setting new curb.~~			"Lin		"		
	resetting old curb.		0 20√	"	"	"		

Contractor will state price per sq. yd. for repaving in street. Returns with same material now on the ground.

0.30 per Sq. yard.

We hereby certify that this PROPOSAL is made without any connection with any other person or persons making any bid or proposal for the above work; and no member of Councils or other officer of the city is directly or indirectly interested therein, or any portion of the profits thereof.

Name, BOOTH & FLINN, LIMITED,
WM. FLINN,
Chairman.

Address, ————————

BOND.

KNOW ALL MEN BY THESE PRESENTS, That Booth & Flinn, Ltd., C. H. Stoltzenbach and P. M. Pfeil, of the County of Allegheny and Commonwealth of Pennsylvania, are held and firmly bound unto the City of Pittsburgh in the sum of Ten thousand (10000) Dollars dollars, to be paid to the said City of Pittsburgh, its certain attorney, successors or assigns to which payment well and truly to be made and done, we do bind ourselves, our heirs, executors and administrators, and every of them, jointly and severally, firmly by these presents.

WITNESS our hands and seals, the 25 day of May in the year of our Lord, one thousand eight hundred and ninety three.

WHEREAS, the above bounden Booth & Flinn Ltd. have filed with the Controller of the said City of Pittsburgh, Proposals for the ~~Grading~~ Repaving ~~and Curbing~~ of N. Highland Avenue from Bryant street northwardly, in the said City, to be done under and in pursuance of the Acts of Assembly of the Commonwealth of Pennsylvania authorizing the same, and the Ordinances of the Councils of said City relating thereto: now

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH,

That if the said Booth & Flinn Ltd. shall enter into a written contract with the said City of Pittsburgh as required by said Acts of Assembly and Ordinances, in case the said contract shall be awarded to him or them, and shall well and faithfully keep,

perform and fulfill in all its parts the contract to be made and entered into by and between the said City of Pittsburgh, and the said Booth & Flinn Ltd. for the ~~construction of~~ repaving ~~Sewer on~~ N. Highland avenue from Bryant street northwardly, and the furnishing of all the material therefor in accordance with the aforesaid contract, and shall keep all said work in continuous good repair for the period of five years after the completion and acceptance of the same, and shall from time to time thereafter indemnify the said City of Pittsburgh against all loss, costs and damages which may arise from the non-fulfillment of the contract aforesaid in any manner whatever, or for or by reason of any failure of any kind whatsoever upon the part of the said Booth & Flinn Ltd. contractor to keep and perform fully and faithfully all the terms and conditions therein named and contained, then this obligation to be void, otherwise to be and remain in full force and virtue.

BOOTH & FLINN, LIMITED,
WM. FLINN, (Seal)
Chairman.
———————. (Seal)
C. H. STOLZENBACH. (Seal)
P. M. PFEIL, (Seal)

Sealed and delivered in presence of
GEO. BOOTH.

Commonwealth of Pennsylvania,
County of Allegheny,
City of Pittsburgh,—ss.

On the 25th day of May A. D. 1893, before me

the undersigned authority, personally came C. H. Stolzenbach and P. M. Pfeil, sureties in above and foregoing bond, who being by me severally sworn to depose and say, each for himself, that he is or they are worth the sum of Five thousand (5000) dollars over and above all just debts, legal liabilities, exemptions and encumbrances.

C. H. STOLZENBACH.
P. M. PFEIL.

Sworn and subscribed this 25 day of May A. D. 1893.

G. W. BOOTH,
City Clerk.

No. ———.

Resolved, That the contract awarded by the Department of Public Works May 29, 1893, to Booth & Flinn Ld. for the ~~grading,~~ repaving and curbing of North Highland Ave. from Bryant St. northwardly, at the following prices:

.....	For Grading, ...	the sum of	$.....	per	Cubic Yard.
1590	"	Paving, Asphalt #4	"	$ 2.80	"	Square	"
1580	"	" B. Stone	"	$.....	"	"	"
.....	"	"	"	$.....	"	"	"
.....	"	Curbing new	"	$ .70	"	"	"
.....	"	Curbing old reset	"	$ .20	"	Lineal Foot.	
790	"	Crossing, Granite	"	$ .70	"	Square	"
		Repaving street return	"	$ 30c	"	"	Yd.

Shall be and the same is hereby approved together with the bond attached to said contract.

In Councils June 5th 1893 read three times and passed.

Attest: G. W. BOOTH,
Clerk of Select Council.

Attest: .....,
Clerk of Common Council.

Mayor's Office, ...189..

Approved: .....,
Mayor.

Attest: .....
Mayor's Clerk.

Approved by Mayor June 8th 1893.

C. C. No. 276.

RESOLUTION

Approving Contract
For ~~Grading,~~ Repaving and Curbing
North Highland Ave.

From Bryant St.
~~To~~ Northwardly.
In C C, May 29th 1893.
Referred to Committee on Public Works.

E. J. MARTIN,
Clerk.

In Committee on Public Works, June 2d 1893. Ordered to be returned to Councils with Affirmative recommendation.

E. J. MARTIN,
Clerk.

In C C, June 5th 1893.

Rule suspended, read three times, and finally passed.

E. J. MARTIN,
Clerk.

In S C, June 5th 1893.

Rule suspended, read three times, and finally passed.

G. W. BOOTH,
Clerk.

Presented by

. . . . . .

N. 23.—500–6–7–93.

1893 —809—

#29 E281

CONTRACT

FOR

~~Grading,~~ Repaving and Curbing.
N. Highland Ave.

From Bryant St.
~~To~~ Northwardly.

Awarded to

Booth & Flinn Ltd. Contractor.
Date of Award, May 29/93.
First and Final
Estimate Nov 7/93 $9214.00

[Endorsed]: E–8516. District Court of the United States, District of Oregon. Warren Brothers Company, Complainant, vs. Oskar Huber, Defendant. Plaintiff's Exhibit Contract for Paving North Hiland Avenue, Pittsburgh, Pa. Clarence A. Will-

iams, Notary Public and Special Examiner. My Commission Expires January 19, 1923.

U. S. District Court, District of Oregon. Filed May 15, 1922. G. H. Marsh, Clerk.

Plaintiff's Exhibit No. 32.

PLAINTIFF'S EXHIBIT No. 32—CONTRACT FOR PAVEMENT OF DITHRIDGE STREET, PITTSBURG.

This contract was executed October 27, 1893, between City of Pittsburg and Booth & Flinn, Ltd., and provided for the paving by Booth & Flinn of Dithridge Street, Pittsburg, from Fifth Avenue to Forbes Street.

The provisions of this contract (except for the name and description of the street to be paved) are substantially identical with the provisions of the contract for the paving of North Hiland Avenue, Plaintiff's Exhibit 31 above printed, to which reference is hereby made, except as shown by the following excerpt from said Exhibit 32.

EXCERPT FROM FORM OF AGREEMENT TO BE EXECUTED FOR THE IMPROVEMENT OF DITHRIDGE STREET FROM FIFTH AVENUE TO FORBES STREET, MADE OCTOBER 27, 1893, BETWEEN CITY OF PITTSBURGH AND BOOTH & FLINN, LTD., CONTRACTORS.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT.

No. 3.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock, or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Upon this road-bed so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled, poured with hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a

binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixers, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface of pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt,	from 28 to 43 parts.
No. 4 Pitch,	" 72 " 57 "

The wearing surface shall be composed of:

Asphalt Cement,	from 14 to 18 parts.
Crushed Ligonier Stone,	" 43 " 41 "
Sharp River Sand,	" 43 " 41 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when

compactly rolled with a steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENTS.

No. 4.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock, or other material) shall then be excavated and removed, to the depth of nine (9) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be Ligonier, Granite spalls, or of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Upon this road-bed when rolled there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one

solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition well heated and thoroughly mixed through steam mixers shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt,	from 28 to 43 parts.
No. 4 Pitch,	" 72 " 57 "

The wearing surface shall be composed of:

Asphalt Cement,	from 14 to 18 parts.
Crushed Ligonier Stone,	" 43 " 41 "
Sharp River Sand,	" 43 " 41 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot,

evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass.

PROPOSAL

For The

Grading, Paving and Curbing of Dithridge St. from Fifth Avenue to Forbes Street.

Having examined the Plans and Specifications for the Grading, Paving and Curbing of the said street, in the office of Department of Public Works, and the agreement to be entered into in case of award of contract to us, we do hereby PROPOSE and AGREE to furnish all the Materials, Tools and Labor required to grade, pave and curb the above named Dithridge St. between the points mentioned in strict accordance with the Plans, Specifications and Instructions to the Chief of the Department of Public Works, or his assistant, the Superintendent of Engineering and Surveys, at the following prices:

4400	For	Grading, the sum of	$0.42√	per	Cubic	Yard	
3285	"	Paving, Asphalt	$3.00	"	"	"	" 1
3237	"	" B Stone	$2.50√	"	Square	"	No. 4
	"	Irregular	$1.75	"	"	"	
	"		$	"	"	"	
1900	"	Curbing, the sum of	$0.78√	"	Lineal	Foot	
450	"	Crossing, Granite	$0.80	"	Square	"	

We hereby certify that this PROPOSAL is made without any connection with any other person or persons making any bid or proposal for the above work; and no member of Councils or other officer

of the city is directly or indirectly interested therein, or any portion of the profits thereof.

NAME: ADDRESS,

BOOTH & FLINN, LIMITED,

WM. FLINN (signed)

Chairman.

RESOLVED, That the contract awarded by the Department of Public Works Sept. 11th, 1893 to Booth & Flinn, Ld., for the grading, paving and curbing of Dithridge St. from Fifth Avenue to Forbes St.

at the following Prices:

4400	For	Grading,		the sum of	$ .42 per	Cubic Yard
3285	"	Paving,	Asphalt #4	"	$2.50 "	Square "
1900	"	Curbing		"	$ .78 "	Lineal Foot

Shall be and the same is hereby approved together with the bond attached to said contract.

In Councils October 9, 1893, read three times and passed.

Attest: E. J. MARTIN (Signed)

Clerk of Select Council.

Attest: W. C. GEARING (Signed)

Clerk of Common Council.

Approved by the Mayor October 12th, 1893.

Plaintiff's Exhibit No. 33.

PLAINTIFF'S EXHIBIT No. 33—CONTRACT FOR THE PAVING OF BOND STREET, PITTSBURG.

This contract was executed October 8, 1896, between City of Pittsburg and Booth & Flinn, Ltd., and provided for the paving of Bond Street from

North Hiland Avenue to Wightman's Line, Pittsburg.

The provisions of this contract (except for the name and description of the street to be paved) are substantially identical with the provisions of the contract for the paving of North Hiland Avenue, Plaintiff's Exhibit 31 above printed, to which reference is hereby made, except as shown by the following excerpt from said Exhibit 33.

EXTRACTS FROM AGREEMENT FOR THE IMPROVEMENT OF BOND STREET FROM NORTH HIGHLAND AVENUE TO ROBERT WIGHTMAN'S LINE MADE THE 8th DAY OF OCTOBER, 1896, BETWEEN THE CITY OF PITTSBURGH AND BOOTH & FLINN, LTD., OF PITTSBURGH, CONTRACTORS.

PREPARATION OF ROAD-BED FOR VULCANITE ASPHALT.

PAVEMENT NO. 1.

4. All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter, (be it earth, rock, or other material,) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with broken stone, gravel or sand. The road-bed shall then be truly

shaped and trimmed to the required cross-section and grade, and rolled to ultimate resistance with a roller weighing not less than ten (10) tons. Such portions of the road-bed not practical for rolling shall be consolidated with hand rollers and tampers. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction (the stone to be Ligonier, or granite spalls, or of hard native stone). This layer shall be compactly rolled to the satisfaction of the Director of the Department of Public Works, with a steam roller of not less than ten (10) tons weight. Upon this road-bed, so rolled, shall be laid a layer of Ligonier granite stone, four and one-half (4½) inches in thickness when rolled, then poured with hot composition, distilled especially for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, and a binder, consisting of clean broken Ligonier or granite stone, not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters, and properly mixed with hot composition through steam mixer, shall then, while hot, be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated, and thoroughly mixed through steam mixer, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a

cement prepared with refined Trinidad Lake Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt .....from 28 to 43 parts
No. 4 Pitch .....from 72 to 57 parts

The wearing surface shall be composed of:

Asphalt Cement .....from 14 to 18 parts
Crushed Ligonier Stone .....from 27 to 29 parts
Sharp River Sand .....from 59 to 53 parts

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen, with openings of one-fourth (¼) inch, and heated in revolving heaters, and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder, in such quantity as when compactly rolled with a steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

PREPARATION OF ROAD-BED FOR VULCANITE ASPHALT.

PAVEMENT No. 2.

Preparation of foundation.

5. All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock, or other material), shall then be excavated and removed, to the depth of nine (9) inches below the top line of the pro-

posed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with broken stone, gravel or sand. The road-bed shall then be truly shaped and trimmed to the required cross-section and grade, and rolled to ultimate resistance with a roller weighing not less than ten (10) tons. Such portions of the road-bed not practical for rolling shall be consolidated with hand rollers and tampers. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken so that none shall measure more than three (3) inches in any direction, nor less than two (2) inches. (The stone to be Ligonier or granite spalls or hard native stone.) This layer shall be compactly rolled to the satisfaction of the Director of the Department of Public Works, with a steam roller of not less than ten (10) tons weight. Upon this road-bed, when rolled, there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, and a binder, consisting of clean broken Ligonier or granite stone, not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters, and properly mixed with hot composition through steam mixer, shall then, while hot, be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well

heated and thoroughly mixed through steam mixer, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material, which is a cement prepared with refined Trinidad Lake Asphaltum and composition of pitch (expressly distilled for the purpose), commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt .....from 28 to 43 parts
No. 4 Pitch .....from 72 to 57 parts

The wearing surface shall be composed of:

Asphaltic Cement .....from 14 to 18 parts
Crushed Ligonier Stone .....from 27 to 29 parts
Sharp River Sand .....from 59 to 53 parts

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen, with openings of one-fourth (¼) inch, and heated in revolving heaters, and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder, in such quantity as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass.

PROPOSAL

For The

Grading, Paving and Curbing of Bond Street from N. Highland Avenue to R. Wightman's Line.

Having examined the Plans and Specifications for the grading Paving and Curbing of the said

street, in the office of Department of Public Works, and the agreement to be entered into in case of award of contract to ——, —— do hereby PROPOSE and AGREE to furnish all the Materials, Tools and Labor required to grade, pave and curb the above named Bond Street between the points mentioned, in strict accordance with the Plans, Specifications and Instructions of the Director of the Department of Public Works, at the following prices:

5576	For	Grading,					the	sum of	$ .30	per cu. yd.
5690	"	Vulcanite	Asphalt	Paving	No. 1		"		2.50	per sq. yd.
"	"	"	"	"	No. 2		"		1.85	"
"	"	Sheet	"	"	No. 3		"		2.04	"
"	"	"	"	"	No. 4		"		2.21	"
"	"	Trinidad Sheet	"	"	No. 5		"		2.19	"
"	"	"	" "	"	No. 6		"		2.17	"
"	"	"	" "	"	No. 7		"		1.87	"
"	"	"	" "	"	No. 8		"		1.87	"
"	"	Sheet	"	"	No. 9		"		1.87	"
5665	"	Block	Stone	Paving	No. 1		"		2.18	"
"	"	"	"	"	No. 2		"		1.98	"
"	"	"	"	"	No. 3		"		2.71	"
"	"	Irregular	Stone						$....	

3400	For	Curbing	the sum of	.64	per lin. ft.
	"	" re-set	"	.18	"
225	"	Granite Crossings	"	.55	per. sq. ft.
	"	" re-laid	"	.08	"
	"	Flagstone Sidewalks	"	$....	"
	"	Artificial "	"	$....	"
	"	Asphalt "	"	$....	"
	"	Brick "	"	$....	per sq. yd.

—— hereby certify that this PROPOSAL is made without any connection with any other person or persons making any bid or proposal for the above work; and no member of Councils or other officer of the city is directly or indirectly interested therein, or any portion of the profits thereof.

Name: BOOTH & FLINN, LTD.

WM. FLINN, (Signed)

Chairman.

Address, ——————

RESOLVED, That the contract awarded by the Department of Public Works August 10th, 1896 to Booth and Flinn Ltd. for the grading, paving and curbing of Bond Street from N. Highland Avenue to R. Wightman's line at the following prices:

5576	For	Grading	the sum of	$ .30	per	cubic	Yard
5690	"	Paving, Asphalt #2	"	1.85	"	Square	"
	"	"	"	$....	"	"	"
	"	"	"	$....	"	"	"
	"	"	"	$....	"	"	"
3400	"	Curbing	"	$ .64	"	Lineal	Foot
	"	Crossing	"	$....	"	Square	"

Shall be and the same is hereby approved together with the bond attached to said contract.

In Councils August 31st, 1896, read three times and passed.

Attest: E. J. MARTIN, (Signed)

Clerk of Select Council.

Attest: W. C. GEARING, (Signed)

Clerk of Common Council.

Approved by the Mayor Sept. 3, 1896.

Plaintiff's Exhibit No. 34.

Complete list of all VULCANITE STREETS, constructed in the City of Pittsburgh, showing the date of construction of each, the specifications under which each street was constructed and the contractor who constructed the street.

The first VULCANITE STREET constructed in the City of Pittsburgh, was Forbes Street, extending from Craig Street to Shady Avenue. This street was constructed in 1874 under the patents of Dr. Filbert of Philadelphia, Pa.

The last contract let for VULCANITE PAVEMENT in the City of Pittsburgh, was Susquehanna Street, extending from Homewood Avenue to Braddock Avenue, in August, 1896, to Booth and Flinn, Contractors. This street was completed in July, 1897.

The last VULCANITE STREET completed in the City of Pittsburgh was Bunker Hill Street, extending from Highland Avenue to Cumberland Street. Completed by Booth and Flinn in August, 1898.

VULCANITE STREETS CONSTRUCTED IN PITTSBURGH.

Street	From	To	Year	Specifications.	Contractor
		1874			
Forbes St.	Craig St.	Shady Ave.	1874	1	
Second Ave.	Elba Crossing	B. & O. R. R.	1874	1	
		1888			
Barton St.	Ellsworth Ave.	Center Ave.	1888	2	Booth & Flinn
Diamond St.	Smithfield St.	Diamond Sq.	1888	2	" "
Diamond Sq.			1888	2	" "
Dithridge St.	Fifth Ave.	Bayard St.	1888	2	" "
Linden Ave.	Penn Ave.	Penna R. R.	1888	2	" "
Montour Way	Sixth Ave.	Seventh Ave.	1888	2	" "
Marchand St.	Shady Ave.	Denniston Ave.	1888	2	" "
McPherson St.	Fifth Ave.	Dallas Ave.	1888	2	" "
Strawberry Ay.	Smithfield St.	Grant St.	1888	2	" "
Simen St.	Fifth Ave.	Dallas Ave.	1888	2	" "
Winebiddle Ave.	Penn Ave.	Liberty St.	1888	2	" "

Street	From	To	Year	Specifications.	Contractor
		1889			
Atwood St.	Fifth Ave.	Boquet St.	1889	2	Neuchatel Asph. Co.
Boquet St.	Frazier St.	Semple St.	1889	2	" "
Church Ay.	Sixth Ave.	Strawberry Ay.	1889	2	" "
Cherry Ay.	Third Ave.	Water St.	1889	2	" "
Corday Ay.	Pearl St.	Cedar St.	1889	2	" "
Eighth St.	Penn Ave.	Liberty St.	1889	2	Booth & Flinn
Freiheits Ay.	Sixth Ave.	Virgin Ay.	1889	2	" "
Mawhinney St.	Forbes St.	Southerly	1889	2	Neuchatel Asph. Co.
Negley Ave.	Hampton St.	Roup St.	1889	2	Booth & Flinn
Oakland Sq.			1889	2	Chas. Chanil
Strawberry Ay.	Smithfield St.	Liberty St.	1889	2	Booth & Flinn
Scott Ay.	Penn Ave.	Duquesne Way	1889	2	" "
State Ay.	Fifth Ave.	Wylie Ave.	1889	2	" "
Slocum Ay.	Penn Ave.	Liberty St.	1889	2	" "
		1890			
Aiken Ave.	Fifth Ave.	Ellsworth Ave.	1890	2	Booth & Flinn
Alder St.	Highland Ave.	Shady Ave.	1890	2	" "

Street	From	To	Year	Specifications.	Contractor
Copeland St.	Ellsworth Ave.	Walnut St.	1890	2	" "
Corday Ay.	Cedar St.	Edmund St.	1890	2	" "
Denniston Ave.	Fifth Ave.	Penn Ave.	1890	2	" "
Ellsworth Ave.	Penn Ave.	Neville St.	1890	2	" "
Highland Ave.	Penn Ave.	Bryant St.	1890	2	" "
Howe St.	Highland Ave.	Denniston Ave.	1890	2	" "
Kirkpatrick St.	Wylie Ave.	Webster Ave.	1890	2	" "
Lilac St.	Ellsworth Ave.	Westminster Pl.	1890	2	" "
Maddock Ay.	Penn. Ave.	Duquesne Way	1890	2	" "
Penn Ave.	Fifth Ave.	City Line	1890	2	" "
Stanton Ave.	Highland Ave.	Heberton St.	1890	2	" "
Stanton Ave.	Highland Ave.	Clearview St.	1890	2	" "
		1891			
Amberson Ave.	Fifth Ave.	Penna R. R.	1891	2	Booth & Flinn
Aiken Ave.	Ellsworth Ave.	Center Ave.	1891	2	" "
Barton St.	Fifth Ave.	Forbes St.	1891	2	" "
Baum St.	Highland Ave.	Mellon's Line	1891	2	" "
Boquet St.	Atwood St.	Bates St.	1891	2	" "
Baum St.	Negley Ave.	Mellon's Line	1891	2	" "

—2—

VULCANITE STREETS CONSTRUCTED IN PITTSBURGH.

Street	From	To	Year	Specifications.	Contractor
Center Ave.	Craig St.	Highland Ave.	1891	2	Booth & Flinn
Cherry Ay.	Fifth Ave.	Liberty St.	1891	2	" "
Diamond St.	Grant St.	Ross St.	1891	2	" "
Euclid Ave.	Center Ave.	Mellon's Line	1891	2	" "
Fifth Ave.	Boquet St.	Eastwardly	1891	2	" "
Garland Ay.	Sixth Ave.	Strawberry Ay.	1891	2	" "
Halket St.	Fifth Ave.	Wilmot St.	1891	2	" "
Howe St.	Aiken Ave.	Highland Ave.	1891	2	" "
Humber Ay.	Erin St.	Kirkpatrick St.	1891	2	" "
Hays St.	Negley Ave.	Westwardly	1891	2	" "
Jumonville St.	Fifth Ave.	Forbes St.	1891	2	" "
Juliet St.	Wilmot St.	Cato St.	1891	2	" "
Luna St.	Park Ave.	Everett St.	1891	2	" "
Margaretta St.	Highland Ave.	Negley Ave.	1891	2	" "
Marchand St.	Denniston Ave.	Festival St.	1891	2	" "
Oak Ay.	Liberty St.	Cherry Ay.	1891	2	" "

Street	From	To	Year	Specifications.	Contractor
Park Ave.	Frankstown Ave.	Shetland St.	1891	2	Booth & Flinn
Roup St.	Fifth Ave.	Negley Ave.	1891	2	" "
Rural St.	Highland Ave.	Negley Ave.	1891	2	" "
Rebecca St.	Friendship Ave.	Liberty Ave.	1891	2	" "
Ross St.	Fifth Ave.	Diamond St.	1891	2	" "
Sheridan St.	Ellsworth Ave.	Penn Ave.	1891	2	" "
Wilmot St.	Boquet St.	Cunliff Run Brg.	1891	2	" "
Westminster St.	Aiken Ave.	Amberson Ave.	1891	2	" "
		1892			
Cherry Ay.	Fifth Ave.	Third Ave.	1892	4	" "
Craig St.	Fifth Ave.	Center Ave.	1892	4	" "
Callowhill St.	Highland Ave.	Mellon St.	1892	4	" "
College Ave.	Howe St.	Fifth Ave.	1892	4	" "
Evans Ay.	Liberty Ave.	Duquesne Way	1892	4	" "
Elgin Ave.	Highland Ave.	Mellon St.	1892	4	" "
Forbes St.	Craft Ave.	St. Pierre St.	1892	3	" "
Fifth Ave.	Wilkins Ave.	Eastwardly	1892	4	" "
Flavel St.	Station St.	Everett St.	1892	4	" "
Greenfield Ave.	Kearcher St.	Wheatland St.	1892	4	" "

Street	From	To	Year	Specifications.	Contractor
Hoeveler St.	Highland Ave.	Collins Ave.	1892	4	Booth & Flinn
Hogg Ay.	Smithfield St.	Cherry Ay.	1892	4	" "
Keatings Ay.	Roberts St.	Divillier St.	1892	4	" "
Linden Ave.	Penn Ave.	Bruce's Line	1892	4	" "
Mayflower St.	Larimer Ave.	Kenesaw Ay.	1892	4	" "
Mellon St.	Callowhill St.	Elgin St.	1892	4	" "
McCully St.	Highland Ave.	Negley Ave.	1892	4	" "
Poplar Ay.	Hickery Ay.	Washington St.	1892	4	" "
Parker St.	College Ave.	O'Hara St.	1892	4	" "
S. Highland Ave.	Penna R. R.	Penn Ave.	1892	4	" "
Thomas St.	Homewood Ave.	Eastwardly	1892	4	" "
Wallingford St.	Neville St.	Morewood Ave.	1892	4	" "
		1893			
Atlantic Ave.	Penn Ave.	Liberty Ave.	1893	4	" "
Alder St.	Highland Ave.	Spahr St.	1893	4	" "
Aurelia St.	Shady Ave.	Denniston St.	1893	4	" "
Broad St.	Negley Ave.	Highland Ave.	1893	4	" "
Baum St.	Negley Ave.	Rebecca St.	1893	4	" "
Beatty St.	Rural St.	Rippey St.	1893	4	" "

VULCANITE STREETS CONSTRUCTED IN PITTSBURGH.

Street	From	To	Year	Specifications.	Contractor
Beatty St.	Stanton Ave.	Hays St.	1893	4	Booth & Flinn
Bluff St.	Marion St.	Westwardly	1893	4	" "
Bayard St.	Neville St.	Morewood St.	1893	4	" "
Cato St.	Juliet St.	McKee Place	1893	4	" "
Claybourne St.	Aiken Ave.	Graham St.	1893	4	" "
Castleman St.	Amberson Ave.	Morewood Ave.	1893	4	" "
Fifth Ave.	Highland Ave.	Denniston Ave.	1893	4	" "
Hamilton Ave.	Fifth Ave.	Homewood Ave.	1893	4	" "
Homewood Ave.	Penn Ave.	Frankstown Ave.	1893	4	" "
Harvard St.	Highland Ave.	Sheridan Ave.	1893	4	" "
Highland Ave.	Bryan St.	Highland Park	1893	4	" "
Homewood Ave.	Penn Ave.	Cemetery Bridge	1893	4	" "
Hamilton Ave.	Homewood Ave.	Old City Line	1893	4	" "
Ivy St.	Ellsworth Ave.	Fifth Ave.	1893	4	" "
Lawn St.	Hamlet St.	Westwardly	1893	4	" "
Lang Ave.	Penn Ave.	Northwardly	1893	4	" "
Lexington Ave.	Penn Ave.	Reynolds St.	1893	4	" "

Street	From	To	Year	Specifications.	Contractor
Meyran Ave.	Forbes St.	Southerly	1893	4	Booth & Flinn
McKee Place	Forbes St.	Ward St.	1893	4	" "
Neville St.	Ellsworth Ave.	Wallingford St.	1893	4	" "
Pacific Ave.	Penn Ave.	Liberty Ave.	1893	4	" "
Summerlea St.	Ellsworth Ave.	Walnut St.	1893	4	" "
Stratford Place			1893	4	" "
Woodlawn Ave.	Forbes St.	Eastwardly	1893	4	" "
Walnut St.	Negley Ave.	Aiken Ave.	1893	4	" "
York Ay.	Louisa St.	Bates St.	1893	4	" "
		1894			
Black St.	Negley Ave.	Westwardly	1924	6	" "
Bunkerhill St.	Highland Ave.	Euclid Ave.	1894	6	" "
Bluff St.	Magee St.	Gist St.	1894	6	" "
Craft Ave.	Fifth Ave.	Southerly	1894	6	" "
Dithridge St.	Bayard St.	Center Ave.	1894	6	" "
Dithridge St.	Fifth Ave.	Forbes St.	1894	6	" "
Fifth Ave.	Penn Ave.	Denniston Ave.	1894	6	" "
Harvard St.	Negley Ave.	Highland Ave.	1894	6	" "

Street	From	To	Year	Specifications.	Contractor
Mayflower St.	Larimer Ave.	Lincoln Ave.	1895	6	Booth & Flinn
Meyran Ave.	Ward St.	Northwardly	1894	6	" "
Neville St.	Ellsworth Ave.	Fifth Ave.	1894	6	" "
Oneida St.	Grandview Ave.	Virginia Ave.	1894	6	" "
Smith St.	Mobile St.	Hazlewood Ave.	1894	6	" "
Sheridan St.	Stanton Ave.	Northwardly	1894	6	" "
South Highland	Fifth Ave.	Alder St.	1894	6	" "
		1895			
Amber St.	Baum St.	Friendship Ave.	1894	6	" "
Atlantic Ave.	Cypress St.	Penna R. R.	1895	6	" "
Bluff St.			1895	6	" "
Boquet St.	Fifth Ave.	Forbes St.	1895	6	" "
Craft Ave.			1895	6	" "
Farragut St.	Stanton Ave.	McCully St.	1895	6	" "
Graham St.	Potter St.	Center Ave.	1895	6	" "
Herdman Ay.	Broad St.	Rural Ave.	1895	6	" "
Heberton St.	Stanton Ave.	Grafton St.	1895	6	" "
Lilac St.	Fifth Ave.	Westminster St.	1895	6	" "
Mathilda St.	Penn Ave.	Friendship Ave.	1895	6	" "

VULCANITE STREETS CONSTRUCTED IN PITTSBURGH.

Street	From	To	Year	Specifications.	Contractor
Mellon St.	Hays St.	Stanton Ave.	1895	6	Booth & Flinn
Mellon St.	McCully St.	Stanton Ave.	1895	6	" "
Meyran Ave.	Fifth Ave.	Forbes St.	1895	6	" "
Noble St.	Potter St.	Claybourne St.	1895	6	" "
Osceola St.	Liberty Ave.	Cypress St.	1895	6	" "
Roup Place	S. Negley Ave.	Fairmount St.	1895	6	" "
Shady Ave.	Fifth Ave.	Penn Ave.	1895	6	" "
Sheridan Ave.	Stanton Ave.	Grafton St.	1895	6	" "
St. Clair St.	Penn Ave.	McCully St.	1895	6	" "
Walnut St.	S. Negley Ave.	S. Highland Ave.	1895	6	" "
Woodworth St.	Atlantic Ave.	Wallace Line.	1895	6	" "
		1896			
Bellefield Ave.	Forbes St.	Center Ave.	1896	6	" "
Bellefonte St.	Ellsworth Ave.	Walnut St.	1896	6	" "
Collins Ave.	Stanton Ave.	Hoeveler St.	1896	6	" "

Street	From	To	Year	Specifications.	Contractor
Edmond St.	Penn Ave.	Friendship Ave.	1896	6	Booth & Flinn
Emerson St.	Fifth Ave.	Walnut St.	1896	6	" "
Evaline St.	Penn Ave.	Liberty Ave.	1896	6	" "
Filbert St.	Walnut St.	Ellsworth Ave.	1896	6	" "
Forbes St.	Shady Ave.	Beechwood Ave.	1896	6	" "
Friendship Ave.	Winebiddle Ave.	Pacific Ave.	1896	6	" "
Friendship Ave.	Negley Ave.	Euclid St.	1896	6	" "
Hickery Ay.	Fountain St.	Webster Ave.	1896	6	" "
Kelly St.	Fifth Ave.	Old City Line.	1896	6	" "
Lang Ave.	Penn Ave.	Homewood Cem.	1896	6	" "
Neville St.	Present Pave.	Center Ave.	1896	6	" "
Pacific Ave.	Penn. Ave.	Dauphin St.	1896	6	" "
Spahr St.	College St.	Ellsworth Ave.	1896	6	" "

Street	To	From	Year	Specifications.	Contractor
		1897			
Beitler St.	Highland Ave.	Shakespeare St.	1897	6	Penn'a Asph. Co.
Bond St.	Highland Ave.	Wightmans Line	1897	6	Booth & Flinn
Collins Ave.	Stanton Ave.	Jackson St.	1897	6	" "
Chislett St.	Ruthledges Prop.	Stanton Ave.	1897	6	Penn'a Asph. Co.
Euclid Ave.	Penn Ave.	Bunkerhill St.	1897	6	Booth & Flinn
East End Ave.	Penn Ave.	Treffingers Prop.	1897	6	" "
Finance St.	Homewood Ave.	Braddock Ave.	1897	6	" "
Juliet St.	Cato St.	Frazier St.	1897	6	Penn'a Asph. Co.
Lowell St.	Frankstown Ave.	Renfrew St.	1897	6	" "
Susquehanna St.	Homewood Ave.	Braddock Ave.	1897	6	Booth & Flinn
St. Clair St.	McCully St.	Bunkerhill St.	1897	6	" "
		1898			
Bunkerhill St.	Highland Ave.	Cumberland St.	1898	6	Booth & Flinn

The following are sections of specifications adopted by the City of Pittsburgh governing the construction of VULCANITE STREETS.

These specifications are from the year 1888 to 1898 and shall be designated as Nos. 1–2–3–4–5–6 and 7.

(1)

Under the patents of Dr. Filbert.

(2)

Specifications used by the City of Pittsburgh from year 1898 to and including 1891.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT.

No. 2.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller not less than twelve (12) tons weight, so as to make the filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken that none shall measure more than two and one-half (2½) inches in any direction nor less

than two (2) inches (the stone to be hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys or his assistant, with a steam roller of not less than twelve (12) tons weight. Upon this road-bed so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled poured with hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices, or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand hydraulic cement and composition, well heated and thoroughly mixed through steam mixers, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt	from 28 to 43 parts
No. 4, Pitch	" 72 " 57 "

The wearing surface shall be composed of:

Asphal Cement	from 14 to 18 parts
Crushed Ligonier Stone	" 43 " 41 "
Sharp River Sand	" 43 " 41 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

(3)

Specifications used by the City of Pittsburgh from year 1892 to and including 1893:

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT.

No. 3.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and

carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys, with a steam roller of not less than ten (10) tons weight. Upon this road-bed so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled, poured with hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixers, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with re-

fined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) Commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt ..... from 28 to 43 parts
No. 4 Pitch .....from 72 to 57 parts

The wearing surface shall be composed of:

Asphalt Cement ..... from 14 to 18 parts
Crushed Ligonier Stone .. from 43 to 41 parts
Sharp River Sand ..... from 43 to 41 parts

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with a steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

(4)

Specifications used by the city of Pittsburgh from year 1892 to and including 1893.

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENT No. 4.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of nine (9) inches below the top line of the proposed

pavement. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be Ligonier Granite spalls, or of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Ppon this road-bed when rolled there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with a hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition well heated and thoroughly mixed through steam mixers shall then be put upon the binder to bring the surface to perfect grade and

smoothness. Upon this surface will be laid the wearing surface of the pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt ..... from 28 to 43 parts
No. 4 Pitch ..... from 72 to 57 parts

The wearing surface shall be composed of:

Asphalt Cement ..... from 15 to 18 parts
Crushed Ligonier Stone ... from 43 to 41 parts
Sharp River Sand ..... from 43 to 41 parts

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass.

(5)

Specifications used by the City of Pittsburgh from year 1894 to and including 1897.

PREPARATION OF ROAD-BED FOR VULCANITE ASPHALT

Pavement No. 1.

All paving and other stones necessary to be removed shall be taken up and immediately removed

from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of sixteen and one-half (16½) inches below the top line of the proposed pavement. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed and the space filled with broken stone, gravel or sand. The road-bed shall then be truly shaped and trimmed to the required cross section and grade, and rolled to ultimate resistance with a roller weighing not less than ten (10) tons; such portions of the road-bed not practical for rolling shall be consolidated with hand rollers and tampers. Upon the foundation thus prepared shall be laid a bed of broken stone eight (8) inches in depth when rolled, said stone to be broken so that none shall measured more than three (3) inches in any direction, (the stone to be Ligonier, or granite spalls, or hard native stone). This layer shall be compactly rolled to the satisfaction of the Director of the Department of Public Works, with a steam roller of not less than ten (10) tons weight. Upon this road-bed, so rolled shall be laid a layer of Ligonier granite stone four and one-half (4½) inches in thickness when rolled, then poured with hot composition, distilled especially for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, and a binder, consisting of clean broken Ligonier or granite stone, not to exceed one and one-half (1½) inches in diameter, well heated through re-

volving heaters, and properly mixed with hot composition through steam mixer, shall then, while hot, be spread evenly in such quantity as to be two (2) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixer, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Lake Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions.

Asphalt ..... from 28 to 43 parts
No. 4 Pitch ..... from 72 to 57 parts

The wearing surface shall be composed of:

Asphalt Cement ..... from 14 to 18 parts
Crushed Ligonier Stone ... from 27 to 29 parts
Sharp River Sand ..... from 54 to 57 parts

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters, and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder, in such quantity as when compactly rolled with steam roller, to be two (2) inches in thickness, the whole making one homogeneous mass.

(6)

Specifications used by the City of Pittsburgh from year 1894 to and including 1897.

PREPARATION OF ROAD-BED FOR VULCANITE ASPHALT

Pavement No. 2.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall be excavated and removed, to the depth of nine (9) inches below the top line of the proposed pavement. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed and the space filled with broken stone, gravel or sand. The road-bed shall then be truly shaped and trimmed to the required cross section and grade, and rolled to ultimate resistance with a roller weighing not less than ten (10) tons, such portions of the road-bed not practical for rolling shall be consolidated with hand rollers and tampers. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken so that none shall measure more than three (3) inches in any direction, nor less than two (2) inches. (The stone to be Ligonier, or granite spalls, or hard native stone). This layer shall be compactly rolled to the satisfaction of the Director of the Department of Public Works, with a steam roller of not less than ten (10) tons weight. Upon this road-bed when rolled, there shall be poured a hot compo-

sition, distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, and a binder, consisting of clean broken Ligonier or granite stone, not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer shall then while hot, be spread evenly in such quantity as to be one and one-half inches (1½) in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixer, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The Binding material which is a cement prepared with refined Trinidad Lake Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt	from	28	to	43 parts
No. 4 Pitch	"	72	"	57 "

The wearing surface shall be composed of:

Asphalt Cement	from	14	to	18 parts
Crushed Ligonier Stone	"	27	"	29 "
Sharp River Sand	"	54	"	57 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch and heated in revolving heaters and properly mixed in a steam mixer shall then be spread while hot, evenly upon the binder, in such quantity as when compactly rolled with steam roller, to be one and one-half inches (1½) in thickness, the whole making one homogenous mass.

(7)

Specifications used by the City of Pittsburgh for the year 1897.

VULCANITE.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of nine (9) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with broken stone, gravel or sand. The roadbed shall then be truly shaped and trimmed to the required cross-section and grade, and rolled to ultimate resistance with a roller weighing not less than ten (10) tons. Such portions of the roadbed not practical for rolling shall be consolidated with hand rollers and tampers. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled, said stone to be broken so that none shall measure more than three (3) inches in any direction nor less than two (2)

inches. (The stone to be Ligonier or granite spawls or hard native stone.) This layer shall be compactly rolled to the satisfaction of the Director of the Department of Public Works, with a steam roller of not less than ten (10) tons weight. Upon this roadbed, when rolled, there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces and a binder, consisting of clean broken Ligonier or granite stone, not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters, and properly mixed with hot composition through steam mixer shall then, while hot, be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coat of fine sand, hydraulic cement and composition, well heated and thoroughly mixed through steam mixer, shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material, which is a cement prepared with refined Standard Asphaltum and composition of pitch (expressly distilled for the purpose), commercially known as No. 4.

The Asphaltic Vulcanized Cement shall be prepared in the following proportions :

Asphalt ..... from 28 to 43 parts
No. 4 Pitch ..... " 72 " 57 "

The wearing surface shall be composed of:

Asphalt Cement ..... from 14 to 18 parts
Crushed Ligonier Stone " 27 " 29 "
Sharp River Sand .... " 54 " 57 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder, in such quantity as when compactly rolled with steam roller, to be one and one-half inches in thickness, the whole making one homogeneous mass.

[Endorsed]: E8516. District Court of the United States, District of Oregon. Warren Brothers Company, Complainant, vs. Oskar Huber, Defendant. Plaintiff's Exhibit History of Pittsburgh Vulcanite Streets With Specifications. Clarence A. Williams, Notary Public and Special Examiner. My Commission Expires January 19, 1923.

U. S. District Court, District of Oregon. Filed May 15, 1922. G. H. Marsh, Clerk.

United States District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 35.

United States District Court, Western District of Pennsylvania.

IN EQUITY—No. 37—November Term, 1915.

WARREN BROTHERS COMPANY

vs.

COUNTY OF ALLEGHENY, I. K. CAMPBELL, J. D. O'NEIL and S. J. TOOLE, County Commissioners, and BOOTH & FLINN, LTD.

AFFIDAVIT OF DONALD McNEIL.

State of Pennsylvania,
County of Allegheny,—ss.

Donald McNeil, being duly sworn, deposes and says:

That he is of lawful age, and that he has been actively engaged in engineering work and has been connected with the firm of Edeburn & Cooper from the year 1892 to 1894. That he has been connected with the engineering and construction department of the City of Pittsburgh from the year 1894 to 1896, during which time he was engaged in the surveying and building of the city streets and highways, and that from the year 1896 to 1908, he was a member of the firm of Lippincott & McNeil, Engineers and Surveyors, having charge of all kinds of engineering and construction work, and that from the year 1908 he has been in the contracting business, building streets, road and highways, and that

he is, at present, president of The Donald McNeil Company, a firm doing street and road paving. That he is familiar with all kinds of street and road paving, all kinds of concrete construction and specifications of same, having had practically twenty-three years' experience in this class of work.

That he has read all the affidavits filed in the above-named case.

That he has never, in the twenty-three years of his experience as engineer and contractor, seen any specifications for concrete, or has he ever built any concrete, or seen any other contractor build concrete construction in which the contractor was allowed to use, in the aggregate in concrete construction, any material finer than sharp sand. The aggregate commonly specified in concrete construction is broken stone, gravel, slag, cinders, or other coarse aggregate, mixed with sand, Portland Cement and water. The sand is usually specified and is required to be clean, coarse and hard, free from dust, loam and other injurious matter. It is understood that Portland Cement is a fine powder, which with the addition of water, crystallizes into a hard and rigid matter. The dust is never allowed to enter into a composition of a Portland Cement structure. Should dust be allowed to enter into the mixture, it will have a tendency to deprive the Portland Cement of its cementing qualities, weakening the whole structure and giving it a chalk-like texture.

He has read the affidavit of William Flinn in this case, in which there are numerous quotations from engineering literature and finds that these quota-

tions, with the exception of the last one, do not refer to the construction of pavements containing a bituminous cement as a binder, but refer to the construction of Portland Cement structures, a subject entirely different from the construction of streets and roadways, and having very little, if anything, in common, barring the fact that a layer of concrete has often been used as a foundation for the support of bituminous wearing surface. Not only is the concrete structure different, but it requires different machinery and apparatus to produce them, one utilizing a cement which is mixed with water and sets into a rigid matter, the other requires the aggregate to be heated, all moisture being driven off, and mixed with a bituminous cement. The two masses are entirely dissimilar, one is plastic and yielding with the bitumen in its original condition, while the other, through the setting of the cement and the evaporation of the water necessary for mixing, is hard, rigid and stone-like. In the last quotation from the Encyclopedia Britannica, which describes a road commonly called macadam road, and it states that the stone for the road is broken in uniform sizes, from two to two and one-half inches in size, and contains about fifty-five per cent of solid matter and forty-five per cent of voids. In a well consolidated road, the void is filled by small fragments, detritus and mud, the result of wear.

Deponent further says that he read the statement of William Flinn, on page eight of his affidavit, stating that he has put down, in the City of Pittsburgh, numerous pavements, the mineral ag-

gregate of which ranged from relatively large pieces to dust, that is from particles from two inches to two and one-half inches in its greatest cross section to dust, and the mineral aggregate of these streets possess inherent stability, which was inherent independent of the binder. That some of the streets thus constructed are:

Bellefield Avenue. Forbes Street.
Lang Avenue. Highland Avenue

Affiant states that he has examined the records of the contracts and the specifications under which pavements were built on—

Bellefield Avenue.
St. Marie Street, formerly Bond Street.
North Highland Avenue.
Elgin Avenue.
Lang Avenue.
Forbes Street.

And that he has examined the contract which contains the specifications for North Highland Avenue and St. Marie Street (formerly Bond Street), and finds that the specifications of the wearing surface of Elgin Avenue and North Highland Avenue to be as follows:

"The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt from 28 to 43 parts.
No. 4, Pitch " 72 to 57 "

The wearing surface shall be composed of:

Asphalt Cement from 14 to 18 parts.
Crushed Ligonier Stone " 43 to 41 "
Sharp River Sand " 43 to 41 "

With sufficient sulphur, lime and cement to harden the asphaltic cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass."

He also finds that the specifications for the wearing surface of Bellefield Avenue, St. Marie Street (formerly Bond Street), Forbes Street and Lang Avenue, are as follows:

"The Asphaltic Vulcanized Cement shall be prepared in the following proportions:

Asphalt	from	28 to 43 parts.
No. 4, Pitch	"	72 to 57 "

The wearing surface shall be composed of:

Asphalt Cement	from	14 to 18 parts.
Crushed Ligonier Stone	"	27 to 29 "
Sharp River Sand	"	54 to 57 "

With sufficient sulphur, lime and cement to harden the asphaltic cement.

The whole to be screened through a revolving screen with openings of one-fourth inch (¼) and heated in revolving heaters and properly mixed in a steam mixer shall then be spread, while hot, evenly upon the binder, in such quantity as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass."

Affiant further states that he has examined the exhibits filed by the defendant marked "Bellefield Avenue, 1896" and "Bond Street, now St. Marie Street, thirty-six feet east of North Highland Avenue," and that on the twenty-first day of July, 1915, caused the removal of pieces of pavement from a spot adjacent to the one described in the affidavit on St. Marie Street, formerly Bond Street, and that he could not find a spot where a sample was removed on Bellefield Avenue, as designated in the affidavit of Mr. Beck, but did find a spot a few feet further away where a sample has been removed, evidently the sample marked Bellefield Avenue. He caused a sample to be removed from Bellefield Avenue at the west curb of Bellefield Avenue, twenty feet north from Forbes Street.

Affiant further states that he has on the same date, removed a sample from all the streets mentioned in the defendant affidavit, to wit:

No. 1, Bellefield Avenue.
No. 2, St. Marie Street.
No. 3, Elgin Avenue.
No. 4. North Highland Avenue.
No. 5, Lang Avenue.
No. 6, Lang Avenue.
No. 7, Forbes Street.

And on July twenty-fourth, removed a sample from Forbes Street, and that he had these samples sawed and makes them an exhibit of his affidavit marked as follows:

No. 1. "Sample of original Vulcanite Pavement, taken from Bellefield Avenue, twenty feet north of

Forbes Street, at the west curb line of Bellefield Avenue. Sample taken July 21st, 1915, at 12:05 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 2. "Sample of Vulcanite Pavement, taken from St. Marie Street, twenty-five feet east of Highland Avenue at the north curb line of St. Marie Street. Sample taken July 21st, 1915, at 1:05 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 3. "Sample of Vulcanite Pavement taken from Elgin Avenue twenty-one and one-half feet west of North Highland Avenue, on south curb line of Elgin Avenue. Sample taken July 21st, 1915, at 1:50 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 4. "Sample of Vulcanite Pavement taken from North Highland Avenue, at the west curb line, thirty-one feet north of Elgin Avenue. Sample taken July 21, 1915, at 2:05 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 5. "Sample of Vulcanite Pavement taken from Lang Avenue, at the west curb line, thirteen feet south of Brashear Street. Sample taken July 21st, 1915, at 2:40 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 6. "Sample of Vulcanite Pavement taken from Lang Avenue at east curb line and the north five foot line of Meade Street. Sample taken July 21st, 1915, at 3:00 P. M. by A. S. Whitehead, Donald McNeil and H. E. Over."

No. 7. "Sample of Vulcanite Pavement taken from Forbes Street at south curb line and twenty feet east of Shady Avenue. Sample taken July 24th, 1915, at 3:50 P. M. by H. E. Over, A. L. Linderman and Donald McNeil."

All the sawed samples show that the streets were constructed according to the contracts and specifications, to wit:

That the whole wearing surface composed of bitumen, sand and crushed Ligonier stone, will pass through a revolving screen having openings one-quarter inch in size.

The samples chopped out by defendant on Bellefield Avenue, was taken from a spot about fifteen feet from the North line of Forbes Street, and twelve feet East of the curb line, and from a spot WHERE THE WEARING SURFACE HAD WORN THROUGH UNTIL THE STONE OF THE BINDER COURSE PROTRUDED. This sample does not represent the street as it was laid, nor as it is at the present date, but only shows the street at that particular spot where travel and time has worn through the top surface.

Bellefield Avenue comprises Eleven thousand one hundred ten (11,110) yards of which there are about twenty-five (25) square yards in the condition as represented by the sample filed by the defendant and analyzed as shown in affidavit of William L. Beck and marked "Exhibit No. 1." This sample as shown by the analysis itself contains sixty and one tenth (60.1) per cent material coarser than one fourth (¼) inch and fifty-

two and five tenth (52.5) per cent of material passing one and one-half (1½) inch and retained on a half (½). From this analysis it is obvious that the binder course has been analyzed together with as much of the wearing surface as still adhered to it. It is not a representative sample of the construction as laid under the contract, nor is it even a sample of the condition of the pavement as found to-day, and not according to specifications. To show the condition of the street where the sample was taken, I hereby attach a photograph markd "Exhibit —," taken under my direction on the 26th day of July, 1915.

Deponent further states that the sample he removed from Bellefield Avenue, was taken from a spot near the curb line where there is very little traffic and therefore the best place to show a pavement as originally laid.

The sample taken from old Bond Street, now St. Marie Street, was from a spot adjacent to the spot where the sample was taken by the defendant, one side of the sample removed by the affiant is a cut made by the defendant in removing their sample. An examination of the cut section shows that this street was also constructed in accordance with specifications aforementioned in which all the material of the wearing surface would pass a screen having one-quarter inch opening mesh. In comparing this section with the analysis in affidavit of William L. Beck, it must be obvious that some of the binder course has been alanyzed with the wearing surface and reported as part of

it and that the void test has been made, not with the aggregate of the wearing surface *per se* but of a said surface mixture and part of the binder course.

That a part of the foundation has been analyzed with the surface in making the tests of the Bond Street, now St. Marie Street, pavement, is further corroborated by the widely diverging report of the two analyses. Mr. H. H. Craver and Mr. William L. Beck no doubt both made correct analysis, and the difference being in the specimens they analyzed.

Affiant further states that the construction of the Vulcanized Pavement as described by the above specifications was begun in the City of Pittsburgh in the year 1874 and abandoned by the City of Pittsburgh in the year 1897.

Affiant further states that he is familiar with all of the pavements in the City of Pittsburgh mentioned or named in all of the defendant's affidavits in which they state that the mineral aggregate in the wearing surface of the streets possess inherent stability, which was inherent independent of the binder, but affiant states that none of these pavements so mentioned in the defendant's affidavit possess in the wearing surface, inherent stability, which is inherent independent of the binder course. In fact these pavements without the binder would have little more stability than coarse sand. These streets at present show a wrinkled condition on the surface which shows that the wearing surface has been creeping and therefore has practically no stability.

Affiant further states that The Donald McNeil Company, is a licensee of Warren Brothers Company, with the privilege of manufacturing and laying of paving material under Warren Brothers patents. Also having the right to license other contractors to lay material mixed and manufactured by the Donald McNeil Company, but The Donald McNeil Company is not allowed in their license agreement with Warren Brothers Company, to license other contractors to mix, manufacture and furnish the paving material under Warren Brothers patents.

Affiant further states that on July 1st, 1915, he collected a sample of pavement, then being constructed by Booth & Flinn, Ltd., on the property of the Atlantic Refining Company, adjoining Grant Boulevard, and that he sent this sample to A. E. Schutte, at Boston, Mass., for analysis. Sample shipped as follows:

"Sample shipped in a box 7" X 11" X 18" and marked on both ends, 'Sterling Model M,' and lined with brown paper, and on the top of material there were old engineering magazines."

Sworn to and subscribed before me this —— day of July, 1915.

_____.

In the United States District Court for the Middle District of Pennsylvania.

IN EQUITY.—No. 37.

November Term, 1915.

WARREN BROTHERS COMPANY

vs.

COUNTY OF ALLEGHENY, J. D. O'NEIL, I. K. CAMPBELL, and S. J. TOOLE, County Commissioners, and BOOTH and FLINN, LIMITED.

AFFIDAVIT OF DONALD McNEIL.

"B."

To be used in reply to the counter-affidavits of defendants filed in this case, on the application for preliminary injunction.

State of Pennsylvania,
County of Allegheny,—ss.

Donald McNeil, being duly sworn says that he is of lawful age, a resident of Pittsburgh, County and State aforesaid, and is president of Donald McNeil Company, a New Jersey corporation, doing business in Pittsburgh, Pennsylvania; and that he has made another reply affidavit in this case.

That on July 21st, 1915, he proceeded, in company with A. S. Whitehead, H. E. Over and A. C. Leslie, all of Pittsburgh, to Bellefield Avenue, in the said city, and at a point on said avenue,

just North of and adjoining the West curb line and twenty feet North of the street line of Forbes Street, he removed a portion of the pavement of Bellefield Avenue. At the time said portion was cut from the said pavement he identified the said portion by placing thereon and attaching thereto a tag or label marked,

> "Sample of original Vulcanite pavement taken from Bellefield Avenue, twenty feet North of Forbes Street at the West curb line of Bellefield Avenue. Sample taken July 21st, 1915, at 12:05 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That he then in company with the said above-named three persons on the same day proceeded to St. Marie Street in said city, and removed a portion of the pavement from St. Marie (formerly Bond Street) twenty-five feet East of Highland Avenue at the North curb line of St. Marie Street and at the time of the removal of said portion of pavement he identified it by placing thereon and attaching thereto a tag marked as follows:

> "Sample of Vulcanite Pavement taken from St. Marie Street, twenty-five feet East of Highland Avenue, at the North curb line of St. Marie Street. Sample taken July 21st, 1915, at 1:05 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That he then and on the same day with the said three persons proceeded to Elgin Avenue in said city and removed a portion of the pavement of Elgin Avenue, twenty-one and one-half feet

West of the street line of North Highland Avenue, at the South curb of Elgin Avenue, which portion at the time it was removed, he identified by placing thereon and attaching thereto a tag marked as follows:

> "Sample of Vulcanite pavement taken from Elgin Avenue, twenty-one and one-half feet West of North Highland Avenue on the South curb line of Elgin Avenue. Sample taken July 21st, 1915, at 1:50 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That he then on the same day in company with said three persons proceeded to North Highland Avenue in said city, and removed a piece of pavement from North Highland Avenue at the West Curb line, thirty-one feet North of Elgin Avenue and at the time said piece of pavement was removed identified the same by placing thereon and attaching thereto a tag marked as follows:

> "Sample of Vulcanite pavement taken from North Highland Avenue at the West curb line, thirty-one feet North of Elgin Avenue. Sample taken July 21st, 1915, at 2:05 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That the affiant on the same day did then proceed in company with said three persons to Lang Avenue in said city, and removed a portion of the pavement of Lang Avenue at the West curb line, thirteen feet South of Brashear Street which portion he, at the time it was removed, identified by

placing thereon and attaching thereto a tag upon which was written as follows:

> "Sample of Vulcanite pavement taken from Lang Avenue at the West curb line thirteen feet South of Brashear Street. Sample taken July 21st, 1915, at 2:40 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That he then, on the same day in company with said three persons proceeded to another spot on said Lang Avenue and removed a portion of the pavement of said Avenue at the East curb line and the North five-foot line of Meade Street and at the time said portion was removed identified the same by placing thereon and attaching thereto a tag upon which was inscribed as follows:

> "Sample of Vulcanite pavement taken from Lang Avenue at East curb line and the North five-foot line of Meade Street. Sample taken July 21st, 1915, at 3:00 o'clock P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over."

That having removed and identified all of the above specified portions of pavement, he, in company with said three persons conveyed all of the same to the office of Donald McNeil Company, in the Jenkins Arcade Building, in the City of Pittsburgh; that he caused the same to be sawed and produces the same as exhibits with this affidavit, marked with tags as above set forth and also with the corporate seal of Donald McNeil Company imprinted on wax adhering to the sample, and also

numbered respectively 1–2–3–4–5 and 6, the number being imprinted in said wax.

That on July 24th, 1915, in the presence of H. E. Over he broke off a portion of the pavement cut from the Bellefield Avenue, known as Exhibit "1," and in the presence of W. P. Thompson delivered the same to C. E. Betz, a chemist employed by the Pittsburgh Testing Laboratory, with directions to analyze the wearing surface of the same, and the said C. E. Betz in the presence of affiant removed from the binder course the wearing surface of said broken off piece. And subsequently the said C. E. Betz delivered to affiant an analysis which is hereto attached, marked "Exhibit A, wearing surface of Bellefield Avenue."

That the said affiant on the 24th day of July, 1915, in company with A. L. Linderman and H. E. Over proceeded to Forbes Street in the City of Pittsburgh, aforesaid and removed a portion of the pavement of Forbes Street at the South curb and twenty feet East of Shady Avenue, and at the time of the removal of the same identified the portions so removed by placing thereon and attaching thereto a tag marked as follows:

"Sample of Vulcanite pavement taken from Forbes Street at the South curb line and twenty feet East of Shady Avenue. Sample taken July 24th, 1915, at 3:50 P. M. by H. E. Over, A. L. Linderman and Donald McNeil."

Which portion so removed affiant caused to be sawed and conveyed to the offices of the Donald McNeil Company in the Jenkins Arcade Building

aforesaid, and the same is filed as an exhibit in this case, marked as above and with the number "7" and the seal of Donald McNeil Company upon adhering wax thereon.

Sworn to and subscribed before me this —— day of July, 1915.

———————.

PITTSBURGH TESTING LABORATORY,
Seventh and Bedford Avenues,
Pittsburgh, Pa.

INSPECTING AND CONSULTING ENGINEERS AND CHEMISTS.
CHEMICAL DEPARTMENT.

No. 47934.
July 26th, 1915.

ANALYSIS OF—ASPHALT PAVEMENT.

SAMPLE MARKED—Sample of Original Vulcanite Pavement taken from Bellefield Ave., 20 ft. North of Forbes St. at West Curb Line of Bellfield Ave.,—Sample taken July.

RECEIVED FROM—The Donald McNeil Company,
Jenkins, Arcade,
Pittsburgh, Penna.

RECEIVED AT LABORATORY—July 24, 1915.
ORDER No. ———

21st, 1915, at 12:05 P. M. by A. S. Whitehead, Donald McNeil, A. C. Leslie and H. E. Over.

Bitumen	10.4%
Sieve Test on Aggregate:	
Passing 200 mesh	= 6.9%
" 100 " retained on 200	= 6.5%
" 80 " " " 100	= 3.7%

Passing	50	mesh	retained	on	80= 9.6%
"	30	"	"	"	50=21.2%
"	20	"	"	"	30=19.5%
"	10	"	"	"	20=16.4%
"	8	"	"	"	10= 5.6%
"	4	"	"	"	8= 9.4%
			Retained	"	4= 1.2%

PITTSBURGH TESTING LABORATORY,
H. H. CRAVER,
LDR. Chief Chemist.

[Endorsed]: E.—8516. District Court of the United States, District of Oregon. Warren Brothers Company, Complainant, vs. Oskar Huber, Defendant. Plaintiff's Exhibit, Affidavits Donald McNeil Identified by Him as Copies of Affidavits Filed in the Case of Warren Brothers Co. vs. Allegheny County, et al. Clarence A. Williams, Notary Public and Special Examiner. My Commission Expires January 19, 1923.

U. S. District Court, District of Oregon. Filed May 15, 1922. G. H. Marsh, Clerk.

[Endorsed]: United States District Court for the District of Oregon. Filed June 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 36.

[NOTE: Plaintiff's Exhibit No. 36 is a duplicate copy of the second, third, fourth and fifth pages of Plaintiff's Exhibit No. 34.]

Plaintiff's Exhibit No. 39.

OREGON STATE HIGHWAY COMMISSION

Sample No. 8957 County—Jackson
Job—Ashland, Calif., Line Type—Cut (Top)
Date sampled—1/25/22 Date tested—1–30–22
Sp. gr. after compression—2.41 & 2.42 Plant .....
Sp. gr. aggregate on 10—2.75 Sta.—71 + 00
Sp. gr. aggregate passing 10—2.64 Laid—1919 16.A√
% Voids after compression—2.8 2.5 V. M. A.—16.7

	%			
A. C.	6.0			
3–2½				
2½–2			As Thick 2¼ in.	
2–1½				
1½–1¼				
1¼–1				
1–¾				
¾–½	33.3			
½–¼	12.8	46.1	49.0	
¼–10	20.1		44.9	
10–20			6.1	
20–30				
30–40	12.0		100.0	
40–50				55.8
50–80	5.4	42.2		36.4
80–100				20.5
100–200	4.7	5.7		
200	5.7	94.3		
Total	100.0			

W. M. S.

(REMARKS ON OTHER SIDE)

OREGON STATE HIGHWAY COMMISSION

Sample No. 8955 County—Jackson
Job—Ashland, Calif., Line Type—Cut (Top)
Date sampled—1/25/22 Date tested—1–30–22
Sp. gr. after compression—2.42 & 2.41 Plant .....
Sp. gr. aggregate on 10—2.78 Sta.—134 + 70
Sp. gr. aggregate passing 10—2.63 Laid—1919
% Voids after compression—.8 V. M. A.—18.5√

	%		
A. C.	7.6		
3–2½			
2½–2			Av. Thick 2½ in.
2–1½			
1½–1¼			
1¼–1			
1–¾			
¾–½	37.7		
½–¼	8.8	46.5	
¼–10	16.6		50.3
10–20			42.9
20–30			6.8
30–40	11.4		———
40–50			100.0
50–80	6.1	39.6	
80–100		6.3	
100–200	5.5	93.7	
200	6.3		
Total	100.0		

W. M. S.

(REMARKS ON OTHER SIDE)

"D" 20

OREGON STATE HIGHWAY COMMISSION

Sample No.—20 County .....
Job—2.34 Type .....
Date sampled .....Date tested .....
Sp. gr. after compression—2.36 Plant .....
Sp. gr. aggregate on 10—2.51 Sta. .....
Sp. gr. aggregate passing 10—2.53 Ld. .....
% Voids after compression—0.4 V. M. A.....

	%		
A. C.	7.0		De Sales St.
3–2½			
2½–2			
2–1½			
1½–1¼			
1¼–1			
1–¾			Extra
¾–½	3.2	7.6	8.0
½–¼	4.4		89.0
¼–10	28.6		3.0
10–20			
20–30			
30–40	34.8		
40–50			
50–80	13.0	82.6	
80–100			
100–200	6.2		
200	2.8	2.8	
Total	100.0		
	972		

W. M. S.

(REMARKS ON OTHER SIDE)

Cut A
B

OREGON STATE HIGHWAY COMMISSION

Sample No. 10015 County .....
Job—B Type .....
Date sampled—A Date tested .....
Sp. gr. after compression—2.29 Plant .....
Sp. gr. aggregate on 10—2.57 Sta. .....
Sp. gr. aggregate passing 10—2.64 Ld. .....
% Voids after compression—1.7 V. M. A.—18.9

	%		
A. C.	7.8		
3–2½			
2½–2			
2–1½			
1½–1¼			
1¼–1			
1–¾			
¾–½	23.0		
½–¼	5.5	28.5	30.9
¼–10	20.4		
10–20			
20–30			
30–40	25.3		
40–50			
50–80	9.9	59.8	64.8
80–100			
100–200	4.2		
200	3.9	3.9	4.3
Total	100.0		
	961		

1442 Arapahoe St.

Denver, Colo.

W. M. S.

(REMARKS ON OTHER SIDE)

#3

OREGON STATE HIGHWAY COMMISSION

Sample No. 9984 County .....
Job—0–2 Type ..... Creosote
Date sampled .....Date tested ..... Wall
Sp. gr. after compression.....Plant .....
Sp. gr. aggregate on 10—3.33 Sta. .....
Sp. gr. aggregate passing 10—2.72 Ld. .....
% Voids after compression.....V. M. A.....

	%		
A. C.	1.4		
3–2½			A. C. 1.4
2½–2			Rock 60.0
2–1½			Sand 38.6
1½–1¼			
1¼–1			
1–¾			
¾–½	38.2		
½–¼	7.3		# 1 & 2 are fine top
¼–10	14.2	59.7	
10–20			
20–30			#s 3, 4, 5, & 6 are lower Top.
30–40	18.6		
40–50			
50–80	12.3		
80–100		35.3	
100–200	4.4		
200	3.6	3.6	
Total	100.0		
	964		

W. M. S.

(REMARKS ON OTHER SIDE)

#4

OREGON STATE HIGHWAY COMMISSION

Sample No. 9984 County .....
Job—O–2 Type .....
Date sampled .....Date tested .....
Sp. gr. after compression.....Plant .....
Sp. gr. aggregate on 10.....Sta. .....
Sp. gr. aggregate passing 10.....Ld. .....
% Voids after compression.....V. M. A. .....

	%	
A. C.	1.8	
3–2½		
2½–2		
2–1½		
1½–1¼		
1¼–1		
1–¾		
¾–½	41.4	
½–¼	10.1	63.4
¼–10	11.9	
10–20		
20–30		
30–40	15.7	
40–50		31.8
50–80	11.7	
80–100		
100–200	4.4	
200	3.0	3.0
Total	100.0	
		970

W. M. S.

(REMARKS ON OTHER SIDE)

#5

OREGON STATE HIGHWAY COMMISSION

Sample No. 9984 County .....
Job—0–2 Type .....
Date sampled ..... Date tested .....
Sp. gr. after compression..... Plant .....
Sp. gr. aggregate on 10..... Sta. .....
Sp. gr. aggregate passing 10..... Ld. .....
% Voids after compression..... V. M. A. .....

	%	
A. C.	1.3	
3–2½		
2½–2		
2–1½		
1½–1¼		
1¼–1		
1–¾		
¾–½	30.5	
½–¼	8.1	55.2
¼–10	16.6	
10–20		
20–30		
30–40	25.0	
40–50		
50–80	11.9	
80–100		40.5
100–200	3.6	
200	3.0	3.0
Total	100.0	
	970	

W. M. S.

(REMARKS ON OTHER SIDE)

#6

OREGON STATE HIGHWAY COMMISSION

Sample No. 9984 County .....
Job—0–2 Type .....
Date sampled .....Date tested .....
Sp. gr. after compression.....Plant .....
Sp. gr. aggregate on 10.....Sta. .....
Sp. gr. aggregate passing 10.....Ld. .....
% Voids after compression.....V. M. A. .....

	%	
A. C.	1.1	
3–2½		
2½–2		
2–1½		
1½–1¼		
1¼–1		
1–¾		
¾–½	38.2	
½–¼	10.0	61.8
¼–10	13.6	
10–20		
20–30		
30–40	20.1	
40–50		
50–80	10.8	34.2
80–100		
100–200	3.3	
200	2.9	2.9
Total	100.0	

971

W. M. S.

(REMARKS ON OTHER SIDE)

#1 Cut—Top

OREGON STATE HIGHWAY COMMISSION

Sample No. 9983 County—Omaha

Job ..... Type—Dump

Date sampled ..... Date tested .....

Sp. gr. after compression—2.48 Plant .....

Sp. gr. aggregate on 10..... Sta. .....

Sp. gr. aggregate passing 10..... Ld. ....

% Voids after compression..... V. M. A. .....

	%				
A. C.	7.0				
3–2½					
2½–2					
2–1½					
1½–1¼					
1¼–1					
1–¾					
¾–½	21.0			Save	
½–¼	10.8	31.8			
¼–10	16.0		34.2		
10–20					
20–30					
30–40	18.1				
40–50					
50–80	16.1	56.5	60.7		
80–100				7.75	
100–200	6.3		5.1		
200	4.7				
			100.0		
Total	100.0				

953

W. M. S.

(REMARKS ON OTHER SIDE)

#2 Cut—Top.

OREGON STATE HIGHWAY COMMISSION

Sample No. 9983 County—Omaha

Job ..... Type—Dump

Date sampled ..... Date tested .....

Sp. gr. after compression—2.48 Plant .....

Sp. gr. aggregate on 10—3.02 Sta. .....

Sp. gr. aggregate passing 10—2.64 Ld. .....

% Voids after compression—3.9 5.0 V. M. A.—18.2 in finished pave

16.8 by cone

	%			
A. C.	6.0			
3–2½				
2½–2				
2–1½				
1½–1¼				
1¼–1				
1–¾			Save	
¾–½	31.0	40.8		
½–¼	9.8		43.4	
¼–10	13.0			
10–20				
20–30				
30–40	16.1			
40–50			52.9	
50–80	14.8			
80–100		36.7		
100–200	5.8	49.7		
200	3.5		3.7	
Total	100.0		100.0	

965

W. M. S.

(REMARKS ON OTHER SIDE)

#3

OREGON STATE HIGHWAY COMMISSION

Sample No. 9983 County—Omaha .....
Job .....Type—Dump
Date sampled .....Date tested .....
Sp. gr. after compression.....Plant .....
Sp. gr. aggregate on 10.....Sta. .....
Sp. gr. aggregate passing 10.....Ld. .....
% Voids after compression.....V. M. A. .....

	%		
A. C.	6.3		
3–2½			
2½–2			
2–1½			
1½–1¼			
1¼–1			
1–¾			
¾–½	18.6		
½–¼	10.8	29.4	31.4
¼–10	17.4		
10–20			
20–30			
30–40	20.5		
40–50		60.2	64.2
50–80	16.6		
80–100			
100–200	5.7		4.4
200	4.1		
			100.0
Total	100.0		

959

W. M. S.

(REMARKS ON OTHER SIDE)

9983 #4

OREGON STATE HIGHWAY COMMISSION

Sample No. 9983 County—Omaha

Job ..... Type—Dump

Date sampled ..... Date tested .....

Sp. gr. after compression..... Plant .....

Sp. gr. aggregate on 10..... Sta. .....

Sp. gr. aggregate passing 10..... Ld. .....

% Voids after compression..... V. M. A. .....

	%		
A. C.	6.3		
3–2½			
2½–2			
2–1½			
1½–1¼			
1¼–1			
1–¾			
¾–½	21.6		
½–¼	9.5	31.1	33.2
¼–10	16.2		
10–20			
20–30			
30–40	19.0		
40–50			
50–80	16.9	58.2	62.1
80–100			
100–200	6.1		
200	4.4		4.7
Total	100.0		100.0

956

W. M. S.

(REMARKS ON OTHER SIDE)

P

OREGON STATE HIGHWAY COMMISSION

Sample No. 10019 County .....
Job—"P" Type .....
Date sampled ..... Date tested .....
Sp. gr. after compression—2.56–2.57–2.58 Plant .....
Sp. gr. aggregate on 10—2.80 Sta. .....
Sp. gr. aggregate passing 10—2.74 Ld. .....
% Voids after compression—.4 V. M. A.—11.7 √
Top ~~12.2~~

	%		
A. C.	4.6	Washington (Penn Ave.)	
3–2½			
2½–2			
2–1½			
1½–1¼			
1¼–1		100%	Agg.
1–¾		47.9	
¾–½	30.0	48.3	
½–¼	15.7	3.8	
¼–10	24.3		
10–20			
20–30			
30–40	10.3		
40–50			
50–80	6.5		
80–100			
100–200	5.0		
200	3.6		
Total	100.0		

964

W. M. S.

(REMARKS ON OTHER SIDE)

V.

OREGON STATE HIGHWAY COMMISSION

Sample No. 10018 County .....

Job .....Type .....

Date sampled .....Date tested—Vt An

Sp. gr. after compression.....Plant .....

Sp. gr. aggregate on 10—2.54 Sta. .....

Sp. gr. aggregate passing 10—2.60 Ld. .....

% Voids after compression..... V. M. A.—14.1 in cone

	%			
A. C.	6.4	Washington inside layer between		
3–2½		fine top & Rock Base.		(100% Agg.
2½–2				(39.5
2–1½				(51.8
1½–1¼				(8.7
1¼–1		No. Sp. G. on this.		
1–¾		wt. in cone	481.5	
¾–½	25.1	Tare	107.5	
½–¼	11.9		——	2565
¼–10	17.8		374.0 ÷ 170 =	2.205 sp. gr.
10–20				——
20–30				.360
30–40	12.4	54.8		
40–50		—— =	21.55√	14.1% Voids
50–80	8.9	2.54		
80–100		38.8	14.93√	
100–200	9.4	—— =	——	
200	8.1	2.60	36.48	
	——	93.6		
Total	100.0	—— =	2.565√	
	919	36.48		

W. M. S.

(REMARKS ON OTHER SIDE)

#1 Cut—Top.

OREGON STATE HIGHWAY COMMISSION

Sample No. 9985 County—Denver.

Job ..... Type .....

Date sampled ..... Date tested .....

Sp. gr. after compression—2.25 Plant .....

Sp. gr. aggregate on 10..... Sta.—H all sample

Sp. gr. aggregate passing 10..... Ld. .....McGovern

% Voids after compression..... V. M. A. .....

	%			
A. C.	8.1			
3–2½				
2½–2				
2–1½				
1½–1¼			Save above #10	
1¼–1				
1–¾				
¾–½	24.5	31.0		
½–¼	6.5		Below #10	
¼–10	21.4		100% Agg.	
10–20				33.7
20–30			33.7	
30–40	25.2		62.0√	
40–50			4.3√	
50–80	7.6	57.0		
80–100			Denver.	
100–200	2.8			
200	3.9			
Total	100.0			
	961			

W. M. S.

(REMARKS ON OTHER SIDE)

#3

OREGON STATE HIGHWAY COMMISSION

Sample No. 9985 County—Denver.

Job ..... Type .....

Date sampled ..... Date tested .....

Sp. gr. after compression—2.25 Plant—H

Sp. gr. aggregate on 10—2.58 Sta. .....

Sp. gr. aggregate passing 10—2.61 Ld. .....

% Voids after compression..... V. M. A. .....

	%			
A. C.	7.4			
3–2½				
2½–2				
2–1½				
1½–1¼				
1¼–1				
1–¾				
¾–½	31.0			37.7
½–¼	3.9	34.9		
¼–10	19.2		100% Agg.	
10–20			~~57.7~~	37.7
20–30			~~37.7~~	57.7
30–40	23.7		~~4.6~~	4.6
40–50		53.4		
50–80	7.4			
80–100				
100–200	3.1			
200	4.3			
Total	100.0			

957

W. M. S.

(REMARKS ON OTHER SIDE)

#2 Cut—Top

OREGON STATE HIGHWAY COMMISSION

Sample No. 9985 County—Denver.

Job ..... Type .....

Date sampled ..... Date tested .....

Spr. gr. after compression—2.25 Plant—H

Sp. gr. aggregate on 10—2.58 Sta. .....

Sp. gr. aggregate passing 10—2.63 Ld. .....

% Voids after compression..... V. M. A. .....

	%		
A. C.	7.5		
3–2½			
2½–2			
2–1½			Save above #10
1½–1¼			
1¼–1			
1–¾			Below #10
¾–½	23.7		
½–¼	4.5	28.2	
¼–10	22.3		100% Agg. 305
10–20			30.5√
20–30			64.5√
30–40	25.7		5.0√
40–50			Denver
50–80	8.5	59.7	
80–100			
100–200	3.2		
200	4.6		
Total	100.0		

W. M. S.

(REMARKS ON OTHER SIDE)

#4

OREGON STATE HIGHWAY COMMISSION

Sample No. 9985 County—Denver

Job ..... Type .....

Date sampled ..... Date tested .....

Sp. gr. after compression—22.5 Plant—H

Sp. gr. aggregate on 10—2.56 Sta. .....

Sp. gr. aggregate passing 10—2.62 Ld. .....

% Voids after compression..... V. M. A.....

	%				
A. C.	7.9				
3–2½					
2½–2					
2–1½					
1½–1¼					
1¼–1					
1–¾			100% agg.	305	
¾–½	23.7	30.5		3.31	62.0
½–¼	6.8		33.1	30.5	57.7
¼–10	21.2		61.8√	37.7	64.5
10–20			5.1√	33.7	61.8
20–30					
30–40	24.7	56.9		4|135.0	4|246.9
40–50				33.75	61.5
50–80	7.9			61.6	
80–100				4.7	
100–200	3.1				
200	4.7			100.0	
Total	100.0				

953

W. M. S.

(REMARKS ON OTHER SIDE)

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 40.

Portland, Oregon, July 6, 1916.

Lab. Nos. P. L. 169 To 174 Inclusive.

Tests made on Samples of Bitulithic Wearing Surface laid by Warren Construction Company 1915 on Columbia River Highway, Multnomah County are Analyses proof a portion of Samples cut by Multnomah County, Ore. Grand Jury.

Samples received at Laboratory June 2, 1916.

Lab. No. P. L. 169 (Sample No. 1) Taken from Columbia River Highway Section A., Station 155 Plus 17.8 4.7′ Left from Centre.

Lab. No. P. L. 170 (Sample No. 2) Taken from Columbia River Highway Section A., Station 157 Plus 24.9. Centre Cut.

Lab. No. P. L. 171 (Sample No. 4) Taken from Columbia River Highway Section B., Station 169 Plus 67.2, 3 Feet to Right of Centre.

Lab. No. P. L. 172 (Sample No. 5) Taken from Columbia River Highway Section B., 350 Ft. E. of E. End Of Shephard's Dell Bridge, 5 Ft. To Right of Centre.

Lab. No. P. L. 173 (Sample No. 7) Taken from Columbia River Highway Section C. 73.6 Ft. W. Of W. End of Oneonta Bridge, 3 Ft. To Right of Centre.

Lab. No. P. L. 174 (Sample No. 8) Taken from Columbia River Highway Section A., Station 150 Plus 25.4, 4 Ft. To Left of Centre.

The other sections of these samples were divided each into 2 parts to be analyzed respectively by R. S. Dulin, Chemist, Bureau of Standards, Portland, Ore., and Edwards and Lazelle, Commercial Chemists, Portland.

	P. L. 169		P. L. 170		P. L. 171		P. L. 172		P. L. 173		P. L. 174	
Bitumen	8.0%		7.7%		7.4%		7.6%		7.9%		8.2%	
Pass 1½	8.7		9.3		16.8		17.1		10.9		13.3	
" 1	9.6		9.5		10.7		13.0		10.7		4.8	
" ¾	17.1		14.3		10.1		19.1		16.3		12.6	
" ½	18.2	53.6	19.9	53.0	21.1	58.7	14.0	63.2	18.2	56	19.4	50.1
" 4	10.0		11.4		10.3		6.1		8.7		10.3	
" 8	2.7	12.7	3.0	14.4	2.7	13.0	1.6	7.7	2.1	10.8	3.0	13
" 10	7.7		7.6		5.8		6.9		3.5		7.4	
" 20	3.7		3.9		3.4		4.8	1.7	4.1			
" 30	3.2		3.2		2.7		3.0		1.3		3.3	
" 40	2.6		2.3		2.0		2.1		2.4		2.7	
" 50	3.9		3.5		3.1		2.1		10.7		5.4	
" 80	1.6		1.4		1.2		1.1		2.9		1.7	
" 100	4.4	27.1	4.0	25.9	3.6	21.8	3.6	23.6	5.7	28.2	4.9	29.5
" 200	6.6	6.8	6.7	6.7	6.5	6.5	5.5	5.5	4.9	4.9	7.1	7.1
	100.00		100.00		100.00		100.00		100.00		100.00	

Sp. Grav.						
Min. Agg.	2.711	2.693	2.812	2.754	2.704	2.687
Sp. Grav.						
Comp. Mixt.	2.413	2.419	2.498	2.48	2.386	2.397
Voids, % Of						
in Min. Agg.	13.0%	13.9%	13.4%	13.4%	14.6%	14.1%
Thickness Av.	2¼″	2⅜″	2½″	3¼″	2½″	2⅛″

Remarks:—Analysis of above samples and Photographs were submitted to the Grand Jury of Multnomah County, Oregon.

Copies to Boston, Portland, E. L. J. CJ.

SAMPLE #1 (P. L. 169 ACTUAL SIZE)

SAMPLE #2 (P. L. 170 ACTUAL SIZE)

SAMPLE #4 (P. L. 171 ACTUAL SIZE)

SAMPLE #5 (P. L. 172 ACTUAL SIZE)

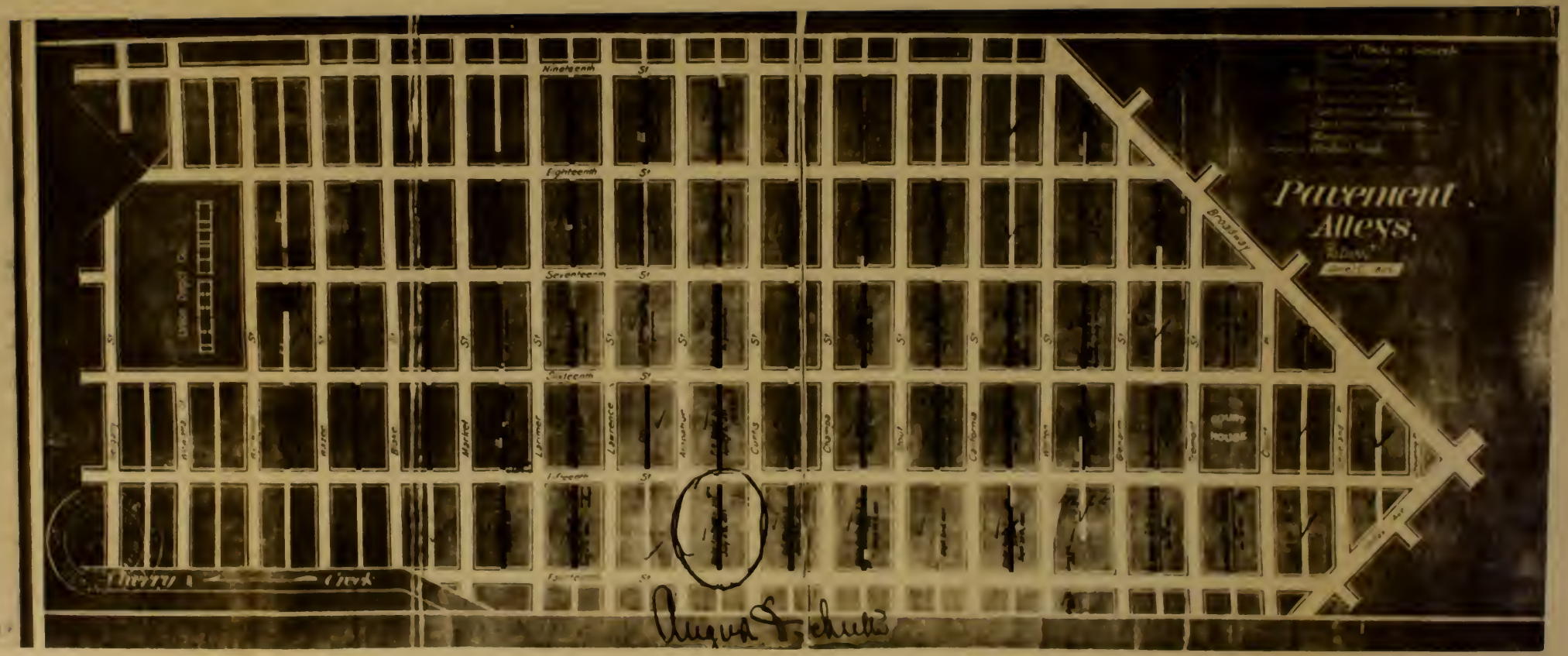
SAMPLE #7 (P. L. 173 ACTUAL SIZE)

SAMPLE #8 (P. L. 174 ACTUAL SIZE)

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

Complainants Exhibit.

Schutte Photographic of Blue Print of Sewer Alleys."



Plaintiff's Exhibit No. 43.

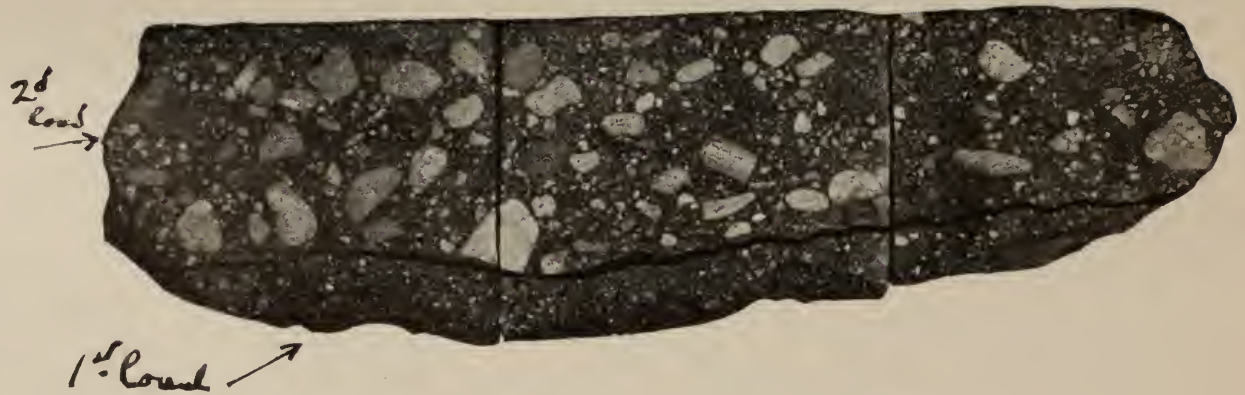
COMPLAINANT'S EXHIBIT — PHOTOGRAPH WEEWATTA STREET, DENVER, COLORADO.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.


Section after cracks with fine sand filled
Sample taken
Asphalt
Asphalt repaired
Butting line
1
2
3
4
5

Plaintiff's Exhibit No. 47.



Complainant's Exhibit Schutte Photograph of Specimen of McGovern Pavement used for Analysis.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 51.

ADVERTISEMENT

Which is to be Included and Considered a Part of this

CONTRACT.

DEPARTMENT OF PUBLIC WORKS.

1893.

TO CONTRACTORS.

SEALED PROPOSALS for the improvement of Dithridge Street from Fifth Avenue to Forbes Street will be received at the office of the City Controller until the 28th day of July at 2 o'clock, P. M.

a. The City of Pittsburgh reserves the right to reject any or all bids, should they deem it for the interest of the City.

b. No contract shall be awarded to any person in arrears to the City, from any cause; or who may have, in former contracts with the City, failed to perform work satisfactory, either in the character of the work or the time unnecessarily consumed in its completion by neglect or wilful delay.

c. The estimated quantities for grading, paving, curbing and otherwise improving Dithridge Street as shown on Letting Plan, No. 189, are to be considered and taken as APPROXIMATE, and the right is expressly reserved by the party of the first part to this agreement, to increase or diminish the said quantities. Nor shall any change of grade alignment, or otherwise vitiate, annul or impair

the contract made and entered into relative to said work, nor constitute any claim for compensation on account of prospective profits. The contractor shall be paid for the amount of work actually performed, at the rates specified in the proposal therefor, and annexed to this contract as part thereof. The full measure of compensation to the contractor to be determined by the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, whose final estimate of said work shall be conclusive evidence thereof, and of binding force.

d. The prices bid are to cover the furnishing of all materials entering into the construction of the work, and the necessary labor and tools required to perform the work in strict accordance with the plans and specifications of said work.

PROPOSAL

for the

Grading, Paving and Curbing of Dithridge St. from Fifth Avenue to Forbes St.

Having examined the Plans and Specifications for the Grading, Paving and Curbing of the said street, in the office of Department of Public Works, and the agreement to be entered into in case of award of contract to us, We do hereby PROPOSE and AGREE to furnish all the Materials, Tools and Labor required to grade, pave and curb the above named Dithridge St. between the points mentioned in strict accordance with the Plans, Specifications and Instructions of the Chief of the Department of Public Works, or his assistant, the Superintend-

ent of Engineering and Surveys, at the following prices:

4400	For Grading, the sum of	$0.42√	per	Cubic	Yard.	
3285	" Paving, Asphalt	$2.50√	"	Square	"	No. 4
3237	" " B Stone	$3.00	"	"	"	" 1
	" Irregular	$1.75	"	"	"	
	" "	$....	"	"	"	
1900	" Curbing,	$0.78√	"	Lineal	Foot.	
450	" Crossing, Granite	$0.80	"	Square	"	

We hereby certify that this PROPOSAL is made without any connection with any other person or persons making any bid or proposal for the above work; and no member of Councils or other officer of the city is directly or indirectly interested therein, or any portion of the profits thereof.

Name, BOOTH & FLINN, LIMITED,
WM. FLINN,

Chairman.

Address———

FORM OF AGREEMENT,

To be Executed for the Improvement of
Dithridge Street
from Fifth Avenue to Forbes Street.

Made and concluded this 27th day of Oct. A. D. 1893, by and between the City of Pittsburgh, through the Chief of Department of Public Works, duly authorized thereto by an ordinance of the Councils of said City, approved 2d day of March, A. D. 1892, party of the first part, and Booth & Flinn, Ld., of Pittsburgh Pa., Contractors, parties of the second part.

WITNESSETH, That the said parties of the second part have agreed, and by these presents do agree with the said party of the first part, for the consideration hereinafter contained, and under the conditions set forth in a "bond" bearing date July 28th, 1893, and hereunto annexed and made part thereof to furnish, at their own proper cost and expense, all the necessary materials, labor and tools, to grade, pave and curb, in a good and substantial manner Dithridge St. from Fifth Avenue to Forbes Street under the conditions and in compliance with the following

SPECIFICATIONS.

GRADING.

terials, v paid

1. To include all materials on the street, both on roadways and sidewalks. All surplus material to be deposited as the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys may direct. The contractor not to be paid for both excavating and filling, but for whichever contains the greater number of cubic yards. All materials furnished and all the work done, which in the opinion of the Chief of the Department of Public Works, or his assistant the Superintendent of Engineering and Surveys, shall not be in accordance with this specification, shall be immediately removed, and other materials furnished and work done, which shall be in accordance therewith.

e work, w prosected.

2. The work under this agreement is to be prosecuted at and from as many different points in such part or parts of the street, on the line of

work, as the said Superintendent of Engineering and Surveys may from time to time direct.

ight of spension.

3. The right to construct any sewer or sewers, or receiving basins and culverts, or build up or adjust any manholes, or to re-set or renew any frames and heads for sewer manholes in said street, and to grant permits for house connections with sewers, or with water or gas pipes, at any time prior to the laying of the new pavement over the line of the same, is expressly reserved by the said Superintendent (and he expressly reserves the right of suspending the work or any portion thereof, on any part of said line of street or streets, at any time during the construction of the same for the purpose above.)

PREPARATION OF ROAD-BED FOR ASPHALT PAVEMENTS.

NO. 4.

repara- on of undation.

All paving and other stones necessary to be removed shall be taken up and immediately removed from the line of the work; the sub-soil or other matter (be it earth, rock or other material) shall then be excavated and removed, to the depth of nine (9) inches below the top line of the proposed pavements. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed, and the space filled with clean gravel or sand and carefully rolled with a steam roller of not less than ten (10) tons weight, so as to make such filling compact and solid. Upon the foundation thus prepared shall be laid a bed of broken stone six (6) inches in depth when rolled,

said stone to be broken that none shall measure more than three (3) inches in any direction nor less than two (2) inches (the stone to be Ligonier, Granite spalls, or of hard native stone). This layer shall be compactly rolled to the satisfaction of the Superintendent of Engineering and Surveys with a steam roller of not less than ten (10) tons weight. Upon this road-bed when rolled there shall be poured a hot composition distilled expressly for the purpose, using not less than one (1) gallon to each square yard, so as to thoroughly permeate all crevices or spaces, thereby making the layer one solid mass, and a binder consisting of clean broken Ligonier granite stone not to exceed one and one-half (1½) inches in diameter, well heated through revolving heaters and properly mixed with hot composition through steam mixer, shall then while hot be spread evenly in such quantity as to be one and one-half (1½) inches in thickness after having been compactly settled by rolling. A scratch coating of fine sand, hydraulic cement and composition well heated and thoroughly mixed through steam mixers shall then be put upon the binder, to bring the surface to perfect grade and smoothness. Upon this surface will be laid the wearing surface or pavement proper. The binding material which is a cement prepared with refined Trinidad Asphaltum and composition of pitch (expressly distilled for the purpose) commercially known as No. 4.

The Asphaltic Vulcanized cement shall be prepared in the following proportions:

Asphalt, from 28 to 43 parts.
No. 4, Pitch, " 72 " 57 "

The wearing surface shall be composed of:

Asphalt Cement, from 28 to 43 parts.
Crushed Ligonier Stone, " 43 " 41 "
Sharp River Sand, " 43 " 41 "

With sufficient Sulphur, Lime and Cement to harden the Asphaltic Cement.

The whole to be screened through a revolving screen with openings of one-fourth (¼) inch, and heated in revolving heaters and properly mixed in a steam mixer, shall then be spread, while hot, evenly upon the binder in such quantity, as when compactly rolled with steam roller, to be one and one-half (1½) inches in thickness, the whole making one homogeneous mass.

CURBING.

Resolved, That the contract awarded by the Department of Public Works Sept. 11th, 1893 to Booth & Flinn Ld. for the grading, paving and curbing of Dithridge St. from Fifth Avenue to Forbes St. at the following prices:

4400	for Grading,	the sum of	$ .42	per	Cubic	Yard.
3285	" Paving, Asphalt #4	"	$2.50	"	Square	"
	" "	"	$	"	"	"
	" "	"	$	"	"	"
	" "	"	$	"	"	"
1900	" Curbing	"	$.78	"	Lineal	Foot.
	" Crossing,	"	$	"	Square	"

Shall be and the same is hereby approved together with the bond attached to said contract.

In Councils October 9th, 1893, read three times and passed.

Attest: E. J. MARTIN,
Clerk of Select Council.

Attest: W. C. GEARING,
Clerk of Common Council.

Mayor's Office ———————— 190 .

Approved ————————,
Mayor.

Attest: ————————,
Mayor's Clerk.

Approved by the Mayor Oct. 12th, 1893.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

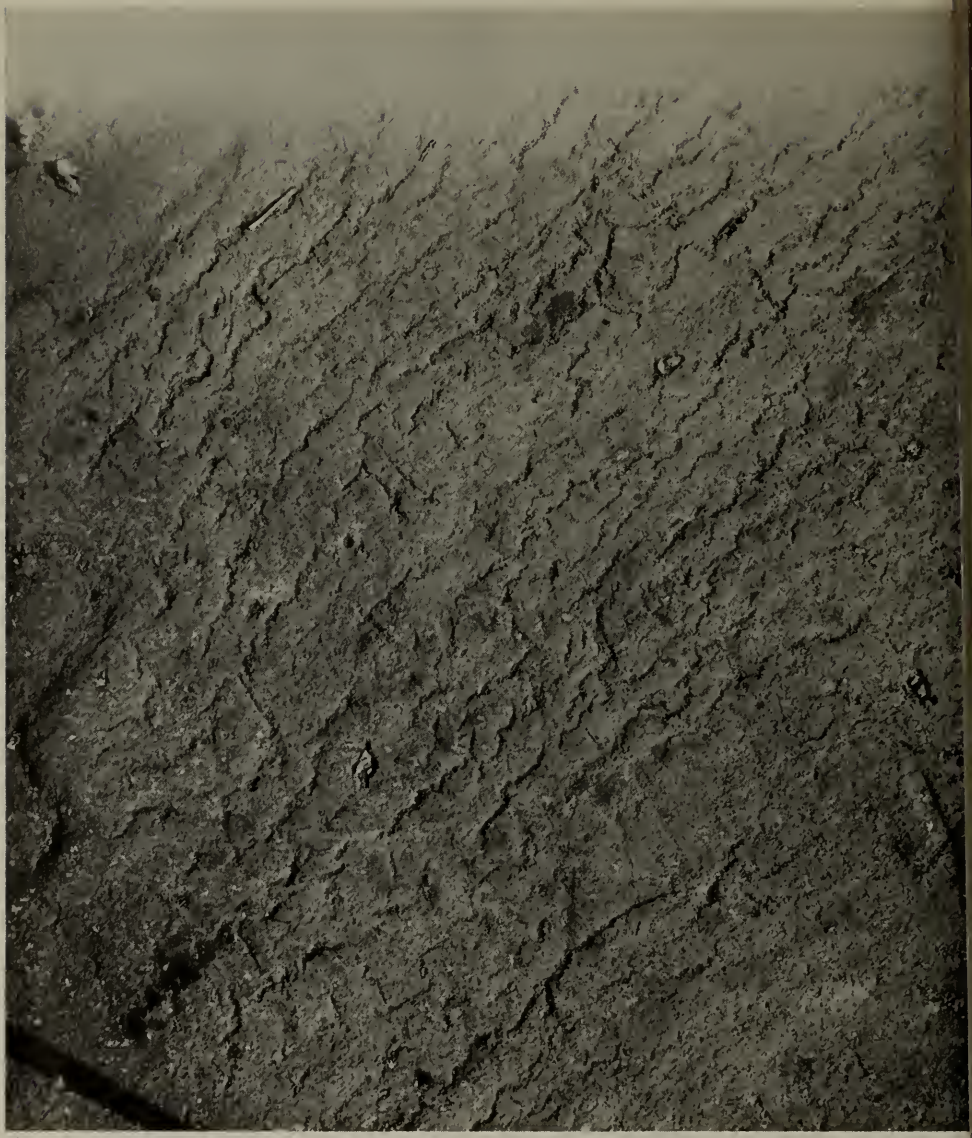
No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Schutte Exhibit No. 2.

Schutte Exhibit No. 3.

Lang Ave., showing soft and typically "wrinkled"

Schutte Exhibit No. 4.



Linden Ave., showing deeply "wrinkled" typical surface. August 10, 1909.

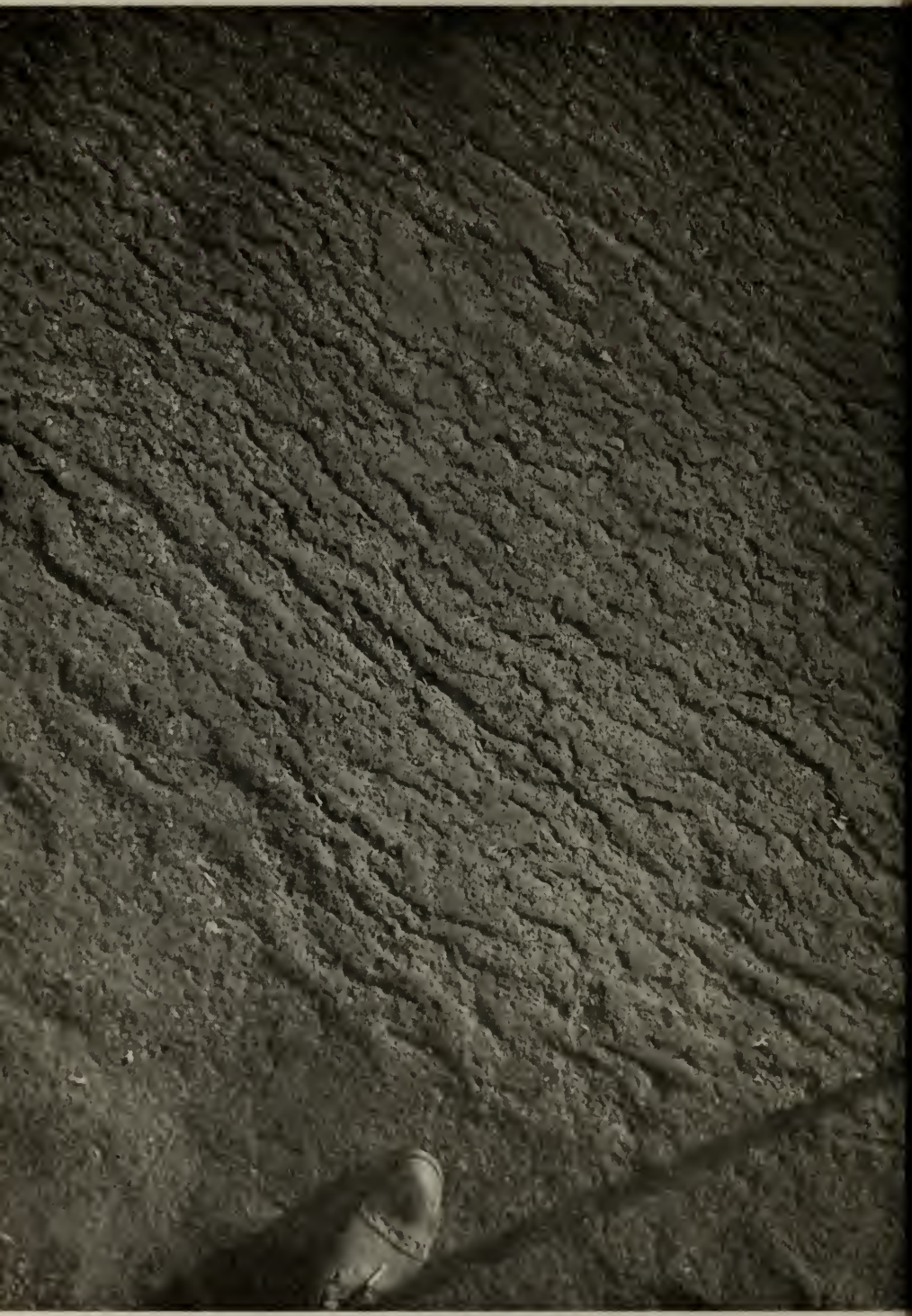
Showing the patched condition of Castleman Street, only about ¼ of the original surface left—showing

Schutte Exhibit No. 6.

224

Schutte Exhibit No. 7.

Schutte Exhibit No. 8.



Schutte Exhibit No. 9.

Ave. Showing spotted condition of street—some hard spots as "A" and some s

A. D. 1884, 12*th February*, No. 3159.

IMPROVEMENTS IN AND RELATING TO MEANS FOR INSULATING AND PROTECTING ELECTRIC WIRES OR CONDUCTORS.

[*Communicated from abroad by William Woods Averell, of Bath, New York, United States of America, late Major-General United States Army.*]

COMPLETE SPECIFICATION.

I William Robert Lake, of the firm of Haseltine, Lake, and Co. Patent Agents, Southampton Buildings, London in the County of Middlesex do hereby declare the nature of said invention for "Improvements in and Relating to means for insulating and protecting electric wires or conductors" and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to means for insulating and protecting electric wires and conductors and comprises an insulating asphaltic-concrete conduit for the reception and protection of electric wires of all descriptions and an improved compound for the said conduit and for insulating electric wires.

A thoroughly practicable system of conduits or pipes for an underground electric system should meet certain requirements, that is to say: The material itself should be of high insulating capacity and of such character as to furnish all necessary protecton to the wires without intervention of other protectors such as metal pipes, or the like.

The conduits should be easy of manufacture and manipulation, economical in first cost; and durable so as to ensure economy of maintenance and repair. Where roadways or streets are to be disturbed in laying the conduit it should be of such character as to create the least disturbance and obstruction during such laying. Where the top of the conduit or system of conduits is at or near the surface of the roadway, it should if practicable, be of such material and manufacture as of itself to form a good and enduring pavement and it should be so constructed as to be affected in the least possible degree by thermal or hygrometric changes.

The objects of this invention are to furnish a material for a system of underground conduits possessing these qualities in the highest degree, and to utilize the same in such a conduit or system of conduits and for the insulation of electric conductors wherever used.

To accomplish this I use an asphaltic concrete, that is a concrete consisting mainly of asphalte or equivalent hydrocarbons and silicious matters. While the proper proportions of these ingredients may be determined in any suitable manner,

to ensure the highest efficiency, it is preferred to ascertain them in the manner hereinafter set forth.

As is well known, both natural asphalt (which herein may be taken as a type of similar hydro-carbons, whether natural or derived from oils or fatty substances) and silica are good insulators, each however having properties which preclude its use alone for this purpose. What I prefer to use is a compound of asphalt and silica.

Silicious particles need some binding agent to unite them in a firm homogeneous mass to prevent movement and saturation which would reduce or destroy the insulative properties of the mass.

Asphalt and other oxigenated hydro-carbons alone are too readily affected by thermal changes, expanding or contracting, or becoming sofe and malleable, or hard and brittle, with changes in temperature.

In view of these facts this invention may be said to consist partly in combining asphalt and silica in such proportions as will furnish only enough cement to fill the interstices of the silicious matter, and thereby render the combination of the two as near a perfect solid as it is possible to attain; partly in the utilization of the matter so prepared as the material from which conduits for underground use are to be made; partly in providing conduits, pipes or tubes for an underground system made as hereinafter set forth from such material, partly in furnishing a matrix holding and protecting tubes of such materials enclosing wires, when it is desired to use such tubes; and partly in insulating electric conductors of all description.

In carrying the said invention into practice what may be called the "voids" of the silicious matter to be used should be accurately ascertained. Suppose two degrees of fineness as regards size of such matter are used (the same principles applying to any number of such degrees) the first being sharp fresh water gravel, well screened, and of a size not larger than a pigeon's egg, and the second ordinary fresh water sand. There are in any given bulk of such material a number of interstices between the points of contact of the units of the mass which, are hereinafter termed "voids."

Starting now with a given bulk of the first element, namely sharp fresh water gravel. The percentage of these "voids" to the entire mass is ascertained in the usual manner by the quantity of water which it will hold, and a proper percentage of fresh water sand is added.

By such experiments the percentage of fine sand which may be mixed with the coarser materials without increasing the bulk may be ascertained for the several varieties used, but there yet will remain "voids" between the units of the mass.

The percentage of these "voids" thus ascertained in volume gives the proportional measure of asphaltic cement (allowance being made for its shrinkage in cooling) which should be added to the silicious matter to form, as nearly as can be done by human agency, a perfect solid, of high insulative capacity, thoroughly waterproof, durable and not affected by thermal or hygrometric changes.

While the above gives a general description of the method of manufacture of the improved asphaltic concrete, I have found it preferable in practice to make some modifications thereof.

When the proportion of sand to be used is ascertained (whether sand alone or in conjunction with the gravel mentioned) I prefer to add to it from five to ten per cent. of ground plaster, or carbonate of lime, of the amorphous kind, in order to partially fill the remaining "voids" to assist in the binding properties of the asphaltic cement by its affinities and to lessen the tendency of the asphaltic cement to contract or expand under thermal changes.

In place of sand a greater or less proportion of pulverized silicious stone or stone dust may be used.

I prefer also not to use the asphalt in its crude or natural state, but to subject it to the action of heat to such a degree that it will resist a high fire test say 208° Fahrenheit.

This eliminates all foreign ingredients, water and the like, and leaves the product a pure, or sufficiently pure asphaltum.

To this mass is then added, while hot say from 15 to 20 per cent. of what is known as the residuum of petroleum, that is liquid bitumen, whose density is 14° to 18° Baumé and which will resist a high fire test.

It follows then that while the asphaltic concrete to be used may be composed of silicious matters and asphaltic cement whose relative proportions are to be ascertained as set forth, the preferable concrete is composed of clean sharp fresh water sand, amorphous carbonate of lime, asphalt and petroleum residuum.

The proportions thereof will vary according to the properties of the materials in any particular locality, and the shrinkage of the cement in passing from a liquid to a solid condition but such proportions can be definitely ascertained by the process hereinbefore described.

These materials are mixed together at a heat which ordinarily should not exceed the lowest degree at which asphaltic cement is maintained in a liquid condition, and the composition is laid or moulded while hot, as hereinafter set forth.

Thus prepared, proportioned, and mixed, a concrete is obtained which, when properly laid, renders the entire conduit solid, so as to prevent the penetration of water, is of high insulative character, comparatively cheap, easy of use, and imperishable by any action of the elements.

In utilizing this concrete for the purpose of an underground electric system, a ditch is dug, upon the bottom of which is laid a foundation of ordinary good hydraulic concrete composed of broken rock, gravel or the like and hydraulic cement to form a firm unyielding base for the layers of insulating concrete to be laid thereon.

Upon such or upon any other suitable base is placed a layer of the improved concrete which is tamped and rammed while hot, it being understood that the sides are supported while the concrete is being compacted.

Upon such layer, wires either naked or insulated, or tubes for the reception of wires are placed.

If wires are used they may be placed thereon from reels which run above the ditch and are so arranged as to lay or reel off the wires, parallel to each other.

If tubes for the reception of wires are to be used, they may be of metal or wooden or paper tubes of proper size laid thereon parallel to each other, or tubes or conduits may be formed by laying upon this (or any other layer) mandrils or formers.

A second layer of the concrete is then placed thereon, rammed and tamped, and other wires or formed tubes are placed upon the said layer.

If the tubes are to be formed of the material *in situ* the forming may be done by the consolidation of the material around the mandrils or formers referred to, which are withdrawn after the hardening or setting of this second or other layer leaving a conduit formed of the concrete itself.

In forming tubes around mandrils or formers, the latter, in order that they may be easily withdrawn after the hardening of the concrete around them, may be oiled or coated with paraffine, or preferably a tube of paper is formed on the mandril or former by winding thereon a sufficient quantity of stiff paper, which may itself have been coated or treated with asphalt. It may be noted that if tubes be used as mandrils they will cool sooner than the surrounding concrete, owing to air passing through them, their subsequent contraction enabling them to be readily withdrawn.

Upon and around such tube the concrete will pack firmly and readily, clinging closely thereto. The interior mandril or former is then withdrawn leaving a conduit or pipe of the concrete lined with paper.

Additional layers are then formed if necessary in the same manner, the result eventually being a prism of solid concrete containing the desired number of wires or tubes for the reception of such wires, either singly or in cables. This concrete prism enclosing the wires is itself of high insulative capacity, economical in first cost, durable, water repellant and of itself, if needed, a good roadway surface.

It need not be laid deep as it will not be affected by thermal or hygrometric changes, and where desired the top layer may itself form the gutter for the roadway or a portion of the roadway itself.

In laying such a conduit or system, it is to be understood, that it may be laid in sections, the sections breaking joint with each other, but the sections of each layer are so laid as to form a continuous homogeneous layer, and the layers united by a flushing of hot asphalt, so as to form a solid continuous homogenous prism enclosing the wires or the tubes for the wires and possessing the qualities before mentioned. Instead of a base of hydraulic concrete, a box of metal or prepared wood or hydraulic concrete may be used the box forming the limits of and aiding in supporting the insulating concrete and wires or tubes, which are laid therein as though upon the hydraulic base. This is preferable where bridges or streams have to be crossed.

In the accompanying drawing

Figure 1 is a perspective view of a prism in a ditch, containing wires and tubes.

Figure 2 is a section thereof laid at the curb or edge of a roadway; while

Figure 3 is a diagram showing large and small tubes enclosed in the prism;

Figure 4 is a view similar to Figure 2, except that the top layer is finished off as part of the roadway.

Figure 5 is a perspective view of a conduit laid in a containing box.

A indicates the side and the bottom of a ditch whose width is that desired for the utimate prism of concrete.

Upon the bottom of this ditch should be laid a foundation B of hydraulic concrete, to afford a firm unyielding bed for the asphaltic concrete.

Upon this base B is laid the first layer C of the asphaltic concrete made as described. It is laid hot and tamped solid before cooling. Preferably, while yet somewhat plastic, wires, as 1, 2, 3, 4, 5, 6, are laid thereon parallel to each other Or cables containing many wires, or single wires having an insulating and protecting covering or naked wires may be laid thereon.

The wires may be easily laid in parallel lines by being unwound from a reel on a carriage whose wheels straddle the ditch, the reel having as many compartments and rolls of wire as there are wires to be laid.

Upon this first layer C is now laid and tamped into place a second layer D. Upon the surface of which tubes *a a* of any suitable configuration in cross section are laid or formed.

It is to be understood that tubes of wires may be placed or formed between any layers, the arrangements shewn in the drawing being merely typical.

The tubes to be embedded may be of any desired material. If they are to be formed or formed and lined say with paper, mandrils or formers are laid in proper position having around them a wrapping of paper as hereinbefore set forth.

The paper tubes thus formed *in situ* are rendered continuous by lapping or passing the end of each over the end of the one in place.

Secured in position a third layer E is placed upon the layer D and thoroughly tamped. This process is repeated until the desired number of layers has been built up.

The joints of the various sections and the lines of union of the layers with each other are made firm and solid by flushing the exposed joints, ends or surfaces with hot liquid asphalte just prior to the addition of the material forming the next section or layer.

The result is a prism of asphaltic concrete, of itself an exceedingly good insulator, thoroughly waterproof, practically indestructible by natural causes and economical in material and labor.

The prism may be placed in any portion of the roadway. In cities especially the more desirable location seems to be at the edge of the roadway, and next the curb, as shewn in Figures 2 and 4 where S indicates the roadway; P the pavement and T the curb, the prism being buried beneath the gutter G.

In Figure 4 a top layer E1 is shewn forming the surface of the prism and finished off to form the gutter for which from its solidity durability and water-proof nature it is well adapted. In fact a top or finishing layer of the prism may well be used as a part of the roadway wherever located.

In Figure 3 is shewn an arrangement typical of the many modifications as to size and distributions of pipes which may be made, there being a large tube H for large cables several smaller ones *h* for smaller cables or collections of wires and small pipes *i i* for one or two wires or small cables.

In Figure 5 is shewn a box B, which may be of metal, wood or composition in which box may be laid the insulating concrete cables, tubes and wires either or all of such form thereof may be desired.

The prism herein represented may be considered a trunk prism or conduit, from which branches may be laid at suitable or desirable points and wires or tubes led off therein from the main prism or conduit.

If desired "man holes" may be made at intervals one end each of two sections or conduits entering therein so as to afford means for ready inspection of the conduits and contents.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is

First. The method of forming an insulating concrete, consisting in first ascertaining the "void" or interstices of the silicious materials used, and then adding a proper percentage of the binding agent thereto, substantially as set forth.

Second. The insulating concrete hereinbefore described, consisting of silicious matter, asphaltum and petroleum residuum combined in the proportions ascertained or determined by the measurement of the interstices or "voids" substantially as set forth.

Third. The insulating concrete hereinbefore described, consisting of silicious matter, asphaltum and petroleum residuum combined substantially as described.

Fourth. An insulating asphaltic concrete conduit formed of silicious materials and tempered asphalt, the percentage of the latter being approximately equal to the ascertained "voids" of the silicious material; and containing wires laid *in situ* substantially as set forth.

Fifth. An insulating asphaltic concrete conduit formed of silicious materials and tempered asphalt, the percentage of the latter being approximately equal to the ascertained "voids" of the silicious materials, and containing tubes, substantially as set forth.

Sixth. An insulating asphaltic concrete conduit formed of silicious materials, and tempered asphalt combined in the proportions set forth, and having its top finished off to form part of the street or roadway substantially as described.

Seventh. An insulating asphaltic concrete conduit formed of silicious materials and tempered asphalt combined in the proportions set forth, and containing pipes or tubes laid and lined with paper *in situ* substantially as set forth.

Dated this 12th day of February, 1884.

HASELTINE, LAKE & CO.,
For the Applicant.

LONDON: Printed by EYRE AND SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1884.

FIG. 1.

FIG. 2.

FIG. 3.

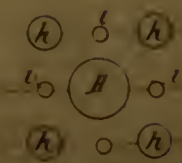
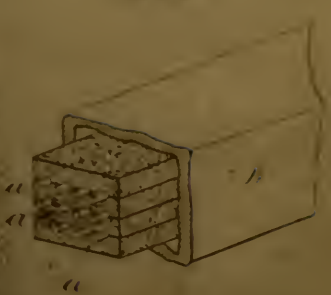


FIG. 4.

FIG. 5



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1884.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed, Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 55.

New York, Sept. 14, 1900.

Mr. George C. Warren,
Utica, N. Y.

Dear Sir:

HAMILTON TAR PAVEMENTS: As you are probably aware, the City of Hamilton has been doing a considerable amount of this work during the past few years, and they claim that the results are entirely satisfactory to them, and that they are going to continue the work on a rather large scale. We have sold them this year about three thousand barrels of tar, which we prepared specially for them, and which they have found very satisfactory. The work, as we understand it, although we have not the specifications at hand, is simply a tar macadam with some light surface dressing. It has occurred to us that the possibilities of this tar pavement work in small places and on streets of light travel are so great that we wish to have an expert report on the character of the work done in Hamilton, its probable cost, and the condition of their oldest pavements, which we understand to be several years. With this end in view we write to ask if you should feel at liberty to make such an investigation and report for us. If you feel that you could do so without conflicting with the other interests that you represent, we should be glad to have a proposition from you as to the expense of the report and to know

when you could undertake it. Your prompt reply will very much oblige.

Yours very truly,
WARREN CHEMICAL & MFG. CO.,
THOMAS M. RIANHARD.

New York, Sept. 25, 1900.

Mr. George C. Warren,
Hamilton, Ontario.

Dear Sir: PAVEMENT REPORT. We are glad to note from your favor written on the train that you have been able to take this matter up so promptly, and in reply beg to say that the work in question has all been done, so far as we are informed, by the City of Hamilton, Public Works Department, direct, they not only having this work in hand, but a considerable scheme for Portland Cement sidewalks, etc., which they also do with their own men. Our sales have been to the Board of Public Works and have not been for pitch, but for what we call Macadam Brand tar which is practically what we used to call at the Old Long Island City Works, Chemical Tar, that is, tar which has been put through the stills and had removed the water and some of the light oils, giving it a heavy body.

The four points which we want to cover particularly in your report would be as follows:

FIRST: Approximate cost of completed work, with information as to cost of labor and materials entering into construction, methods employed, and could they be improved upon.

SECOND: Age and conditions of streets already completed.

THIRD: Probable life of work done in Hamilton, and whether or not this could be lengthened by improved methods.

FOURTH: Adaptability of this class of work to country roads and light travel streets in this country and Canada and could its use be stimulated with satisfactory results by a system of careful canvassing in a company carefully organized for that class of work.

If there are other subjects bearing on this question which you think it would be useful to cover, please include them.

We may say in this connection that the tar used in this work originates in Boston, and there seems to be some filed for this class of work in New England, that Mr. Runkle may arrange to be in Hamilton on Thursday to look over the work with you.

Yours very truly,

WARREN CHEMICAL & MFG. CO.,
THOMAS P. RIANHARD.

Warren Chemical & Mfg. Co.,

Gentlemen: TAR MACADAM.—As requested I visited Hamilton and spent Friday 28th. inst. there investigating the Tar Macadam there, work done and work being done.

1892 WORK.

The first of this class of work done in this City was laid in 1892 under contract with the Hamilton Gas Co. at ——— per square yard, including guarantee on;—King William Street from James to

John—2 blocks. John Street from King William to Main—1 block.

KING WILLIAM STREET.

This street is about 30 ft. wide. Moderate traffic. No railroad tracks.

The City Engineer, E. B. Wingate, who gave me a good deal of information told me this pavement had had but little repair until 1899 when 7 years old he notified the Gas Co. to put it in repair under their guaranty. They did some work filling holes, etc. in 1899 and this year the Gas Co. made arrangement with the City to resurface the entire street with about 1½ inches of stone coated with tar and finishing surface which I will describe later. The first block (James to Hughson) was in the worst condition and was resurfaced about two months ago and the second block will be resurfaced this fall. The portion to be resurfaced is full of holes and depressions from 2″ to 3″ and some 4″ deep, the depressions holding water which must hasten the decay.

On the portion recently surfaced the surface is scaling and "kneading" under travel but is otherwise in good general condition. A fireman in fire engine house on the street says he thinks the pavement was resurfaced once or twice by the Gas Co. before the present work by the City. The discrepancy between this statement and that of the Engineer may be due to the fact that the latter has been in Hamilton only 2 or 3 years and not personally informed of what has been done.

JOHN STREET.

Under arrangement with the Gas Co. the City Engineer resurfaced this street in June this year but did not use the tarred stone except to fill holes and laid about an inch of the finishing surface. This surface is now soft and "kneading" but otherwise in good general condition. What I refer to as "kneading" is the rolling of the surface in places into this scales over the dirty surface of surrounding pavement which is frequently noticed in repairs to asphalt pavements where mixture used is too rich. When the surface is thus "kneaded" to a thin scale it wears off. Both of these streets were originally laid with horse roller compression.

MARKET SQUARE.

Was also laid in 1892 with about 2″ of tarred stone and finishing surface over an old McAdam pavement. It is not therefore, a full tar McAdam. It is said to have had little repairs until 1899 when it was resurfaced and it now presents a fairly uniform surface.

1899 WORK.

With the exception of the above no work appears to have been done in this line until 1899 when the following streets were laid:

Hughson Street from King William to King	1 block
King St. west from Bay about one mile	1 mile.
King St. east to Wellington about	1 mile.
McNab St. Main to King	1 block.

I did not have time to examine all of this work but I think I examined as much as necessary to get an accurate idea of its condition.

HUGHSON ST. AND McNAB STREET.

As noted above these streets are one block each and were laid in 1899. They are subjected to a medium business traffic. One of the foremen in charge of the tar McAdamining work for the City says that this and other streets laid last year are not as good as they now lay for the reason that they were short of screenings for making the finishing surface and did not use enough of this course. The finishing surface is now nearly all worn off. There are a few depressions worn from 1″ to 2″ deep but the general surface is otherwise good.

1900 WORK.

The streets being laid this year are as follows:

James St. north from Stuart St. to Ferry St. Construction commenced.

James St. (East side only) from Hunter to Aberdeen just completed.

York St. from McNab to Queen nearly completed.

Main St. from McNab to John almost half completed.

East Ave. from King to Stinson recently completed.

Victoria Ave. from Stinson to Baxter recently completed.

Of the above I examined the following:

JAMES STREET, NORTH.

None of the work yet open to traffic but a good deal of the data I give below regarding construction was from notes taken on the work. The street is about 45 ft. wide; double street railroad tracks and will have a fairly heavy business traffic. This street

was previously McAdamized and present work consists of removing about 5″ of old surface and replacing with tarred stone without the usual telford foundation.

JAMES STREET, SOUTH.

One side of this street was paved with asphalt a few years ago and the Tar McAdam was completed a few days ago. The work appeared to me the best I saw. The total width of street is about 46 ft. with double track leaving the strip on one side on which tar McAdam has been laid about 14 ft. The street has a moderate traffic.

MAIN STREET.

One block finished and opened to traffic about one week and balance under construction. The block completed (McNab to James) has no track and the other two blocks have double tracks the McAdam being laid in as well as outside of the tracks. Width about 45 ft. Moderate business traffic. The block completed looks well.

YORK STREET.

This work is about ½ mile long. About 48 ft. wide. Double track, moderate business traffic. One side completed about 10 days ago and the other side about half completed. I walked over about half of the completed side. On the block nearest McNab Street (but laid and completed about 10 days) which is the heaviest travelled and of the street the finishing surface is scaling off and being pulverized into mud by the traffic. Other places show on the surface stones loosened by traffic which

will doubtless soon wear into holes. This may be due to defective rolling or weak foundation from other causes.

CONSTRUCTION.

I enclose copy of the specifications of the City on which I would comment as follows:

ROLLING:

This they do with a 12 ton steam roller such as is usually used for McAdam Roads.

TELFORD FOUNDATION.

In this they first lay flat stone and over this small quarry stone spread on the surface and after spreading the larger particles are broken with napping hammers to about 4″ size. The thickness of this course is about 9″ when spread and it rolls to about 6″ in thickness.

FIRST LAYER TARRED STONE:

The specifications call for stone to pass 2½″ ring. What they are using on the street is hand broken stone, broken during the winter varying in size from 2″ to 4″. I should say that fully half of it would not pass 3″ ring. This course is spread about 3″ thick and is only about half coated with tar. I call attention to the size and half tarring of the stone as this is a condition which would probably not be permitted by a Contractor under these specifications although the work is probably practically as good. The stone is hauled to the street in wagons said to hold one-half cord (64 cu. ft.). I measured two of them and they held about 60 cu. ft. or 2¼ yards. You will note that this is an unusually heavy load. The load of stone is dumped on

a wooden platform on the street similar to a street concrete mixing platform but larger (about 20′ x 10′) and the pile separated into two ridges at each side of the platform and the pile covered with heated tar from a kettle on the street and spread with a dipper. Men then throw the coated stones from the ridges to the center of the board. After a small pile (say ½ yard) is in the center of board the surface of the small pile is coated with tar to cover the uncoated surfaces of the stone. More stone shovelled to the cone shaped pile in the center to a thickness of about 6″ surface then again coated with tar and this operation continued until the whole of the stone is handled to the center of the board. It is then wheeled to the work and spread with rake to a thickness of about 3″. This course is not rolled. A criticism I would make on the score of economy is that they have 8 men shovelling and one man spreading tar on the pile. The men are waiting about half their time for the man to get the pile coated. With two men dipping and spreading the tar they could save from one-third to one-half the cost of mixing but in general the laborers seemed to be working more industriously than is usual on municipal work. The City is now paying 18¢ per hour to laborers, 20¢ to the kettle man and I assumed 30¢ to foreman. Of this course 9 laborers, 1 kettle man, and 1 foreman (cost $2.12 per hour) mixed and laid 3 loads say *say* 7 cu. yds. laying 84 sq. yds. in 3½ hours. Cost of labor mixing and laying being about $1.06 per cu. yd. loose measurement or 9¢ per sq. yd. of bottom course laid.

I can see no reason why this cannot be mixed and laid at as low if not lower labor cost as street concrete is mixed and laid which is from 45¢ to 60¢ a yard = 4¢ to 5¢ sq. yd. 3″ thick.

On one batch which I watched they used 30 dippers or pretty close to 30 gals. tar making cost a 7½¢ per gal. about $2.25 for 2½ cu. yds. or $1.00 per cu. yd. or 8¢ sq. yd. of first layer.

SECOND LAYER:

This is mixed and laid in the same manner as the first layer except that more tar is used and stone thoroughly coated. Thickness 2″. I did not visit the crusher but would say that the stone used in this course has passed a 2½″ ring with all dust and fine material passing ¾″ ring separated out.

From the mixing and laying of one batch (2½ yards) which I watched I took the following notes: Time, 10 men and foremen 40 min.=

⅔ hour cost $1.42

Laid 40 sq. yds. making cost of labor .037 per sq.

Tar used 38 gals. at 7½¢=$2.85=

1.27 cu. yd.= .... .071 " "

The kettle man said they used about 4 bbls. to 5 b. loads stone. Counting the barrels 50 gals. each this figures 40 gals. per load which is pretty close to my estimate above taken from the number of dippers used. If 40 gals. is right it would increase cost of tar to 7½¢ per sq. yd.

This course is thoroughly rolled. You will notice the specifications require the stone to be dry which in wet weather requires heating but

in dry weather screened stone as it comes from a crusher is dry if screened free of dust.

As to thickness of the several courses of tarred stone the thickness specified is when spread before rolling. This is very greatly to the advantage of a contractor as he does not lose the compression which would be ¼ to ⅓ and it removes the possibility of dispute as to thickness of material laid after it has been rolled. The loss of ⅓ in the foundation or telford source, however, should be estimated by a contractor to bring the total thickness of completed work up to the specified 10″.

FINISHING SURFACE:

This consists of fine gravel and crusher screenings, of such size as will pass ¼″ screen heated and mixed with tar being about the same consistency as the surface mixture used in tar walks. In Hamilton the heating and mixing is done by machine at the local asphalt paving company's plant but it can be done by hand and is spread and rolled while hot. It is spread ¾″ thick over the rolled "second layer" and after rolling most of it has been compressed into the voids of the coarse stone of the "second layer" leaving about ¼ on top. Over this after rolling crusher screenings are cast and rolled into the surface. Under traffic the portion of the finishing course which remains on top of the "second layer" is quickly worn off and I think the only practical use of this course which is an important one is the binding

together, the coarser stone below levelling the surface and making a more water tight pavement.

COST.

The City Engineer says that in 1899 the cost was about 80¢ per sq. yd. including excavation with wages 15¢ per hour. This year wages have advanced to 18¢ per hour and cost to about 95¢ per sq. yd. I think this cost must be greater and doubt if their records are kept in such a way as to show the actual cost. I would estimate this cost as follows per sq. yd.:

Excavation say 1 ft. deep usually in crushed stone		.15
TELFORD FOUNDATION:		
½ cu. yd. stone at 1.00 delivered on street	.25	
Labor spreading and breaking	.04	
Rolling	.01	.30
First Layer:		
½ cu. yd. stone at 1.20 delivered on street	.10	
About 1½ gals. tar as previously estimated on street at 7½¢	.08	
Labor as previously estimated	.09	.27
Brot. forward		.72

Brot. forward.....		.72
Second Layer:		
1/18 cu. yd. stone at 1.20.....	.07	
About 14/15 gal. tar as previously estimated at 7½¢	.07	
Labor as previously estimated	.04	
Rolling	.01	.19
Note a difference of 50% in relative cost of labor in the two courses, notes of which were taken on different gauge the one on second layer working perceptibly more industriously than on the first layer, probably the two give a fair average cost.		
FINISHING SURFACE:		
1 cu. yd. screenings and gravel at 75¢ at plant=25¢.....	)	4.85
50 gals. tar at 7½¢ 3.75	)cu.yd.=	
Labor and fuel mixing (probably more than this with hired plant) .60	)48=per sq. yd.	
Handling to street ..... .25	)	10¢
Spreading 1¢. Rolling 1¢. Grit on surface 1¢	.03	.13
Total estimated cost in Hamilton sq. yd.		1.04
Based on the average cost of materials and labor in the U. S. I would estimate the cost about as follows per sq. yd.		
Excavation same as Hamilton..		.15

Telford foundation " " " ...		.30
First Layer:		
1/12 yd. stone on street at 1.50=.....	12½	
1½ gals. tar at .06=.....	06½	
Labor	05	.24
Second Layer:		
1/18 yd. stone at 1.50	08½	
14/15 gal. tar at .06.	05½	
Labor	03	
Rolling	01	.18
Finished surface as estimated for Hamilton	13¢	
Less 1½¢ gal. on tar.....	01½	
	11½ say	.12
Total estimated average cost in U. S. making no allowance for contingent expenses		.99
Add for contingencies 10%		.10
Total cost		$1.09

UTILITY.

I have no doubt but that this tar McAdam is a great improvement over ordinary McAdam and believe it will answer very well in towns or streets where nothing better than a second-class pavement can be afforded. I do not, however, consider that there is anything in Hamilton to yet show that the work will prove to be durable without requiring repairs after the first two or three years except under light traffic. There is nothing to show what the cost would be to keep pavement in good condi-

tion for a term of years under a contract requiring a guaranty but under light traffic I should think the cost of repairs, if made frequently, might be low.

Through a report of the U. S. Consul at Hamilton to the Government at Washington and articles by the engineer, the construction is creating a good deal of attention. The City Engineer told me they have very frequent inquiries by mail and by visiting officials. The reports which they give of cost and durability and the present generally satisfactory condition of the streets will, I have little doubt, result in its extension, perhaps quite largely, in other places and probably it will be laid on streets with entirely too heavy traffic for such a construction. Such was the case with the old McAdam and Nicholson and other pavements which looked well when new and caused the public to go wild over them. I should think it would pay manufacturers who have tar to sell to endeavor to create a demand for the tar for this purpose by encouraging smaller towns to adopt it. By giving tar prepared for this purpose a special brand and making a reputation for the brand it would probably be possible to secure better prices for the tar for this than it brings for the most purposes. All the officials, foremen, and laborers with whom I talked in Hamilton spoke very highly of the tar you have furnished, especially in comparison with tar from Toronto and other places which contained water and bothered by foaming. As far as I could judge the chances seemed to be good for their accepting the option of

taking from you for next year 7,000 bbls. at this year's price, notwithstanding that local parties who are preparing to build large coke ovens in Hamilton are offering to sell their tar at lower price and guarantee it to be as good as yours.

I should think it very doubtful if contracts for any considerable amount of work of this character could be gotten at prices which would make it an attractive business for investment. The reports of cost from Hamilton are very low and will probably give cities an idea that is about what they should pay and the competition would soon be such as to probably leave but little profit to a contractor. I would not advise taking a contract at a price which could probably be gotten under specifications requiring a long guaranty which would be very apt to be required. Please be very careful to see that this report is treated for your information only and not used publicly in any way.

Hoping that this will give you the required information, I remain,

Very truly yours,

GEO. C. WARREN.

Utica, N. Y., Oct. 5, 1900.

United States of America,
District of Oregon,—ss.

I, G. H. Marsh, Clerk of the United States District Court for the District of Oregon, do hereby certify that the foregoing copy of Plaintiff's Exhibit No. 55 in cause E–8516, Warren Brothers Co. vs. Oscar Huber, has been by me compared with the original thereof, and that it is a correct transcript

therefrom, and of the whole of such original, as the same appears of record at my office and in my custody.

In testimony whereof I have hereunto set my hand and affixed the seal of said court at Portland, in said District, this 7th day of June, 1922.

[Seal] G. H. MARSH,
Clerk.
By F. L. Buck,
Deputy Clerk.

[Endorsed]: No. E–8516. In the District Court of the United States for the District of Oregon. Warren Brothers Company vs. Oscar Huber. Certified Copy of Plaintiff's Exhibit No. 55.

HAMILTON CITY CORPORATION.
Board of Works Department.
SPECIFICATIONS FOR TAR MACADAM ROADWAYS.

EXCAVATION.

All earth or other material above the sub-grade shall be excavated, so as to conform to the level of the sub-grade, which will be ten inches below the finished surface of the roadway; and should the sub-grade be above the level of the natural ground, then earth shall be deposited until the level of the sub-grade is reached. The sub-grade shall be shaped to the profile and cross section which will be furnished by the City Engineer.

ROLLING.

After the sub-grade has been formed to the proper camber of the road, generally ½ inch per foot or

six inches for 24 foot roadway, to be thoroughly rolled with the steam road roller, and if by this means soft spots are revealed, they shall be filled with good solid material.

SIZE OF STONE.

The first six inches shall be made in the ordinary way for a Macadam or Telford roadway thoroughly rolled. If so required, it may be made of hard broken stone, furnace clinkers, or brick rolled smooth and finished to the required camber of the road. Upon this shall be placed the tarred stone. The first layer—three inches of hand broken stone to pass through a 2½ inch ring, then a two inch layer of machine broken stone, the whole smoothed off with a hand roller and after top dressing is applied thoroughly rolled with a steam roller. On this a layer composed of fine gravel and quarry chippings, mixed in equal proportions, three-quarter inches thick, shall be placed, and well rolled in so as to fill all interstices. Before finishing, a dressing of stone screenings for the purpose of coloring shall be scattered broadcast to be worked in by the traffic. All layers, including the coloring layer, shall be thoroughly compacted by rolling.

METHOD OF MIXING TAR.

The stone to be tarred shall if moist be heated on an iron floor, under which are flues from a fire, until the moisture is driven out. The material in its heated state is then to be thoroughly mixed with a sufficient quantity of tar. The broken stone in warm weather may be sun dried but in all cases the finer course must be artificially dried. At the same

time care must also be taken not to get this material too hot. The tar should be boiled in iron kettles holding one hundred imperial gallons. Eight imperial gallons should be added to each cubic yard of the coarser material or more if required to completely cover the stone, and seventeen to eighteen gallons to the finer kinds of stone.

TAR.

The tar must be pure Coal Tar free from all foreign substances and containing not more than 5 per cent of water and shall contain upon analysis not less than 55 per cent pitch.

WEATHER.

The work must be done in the summer months, and all work must be suspended during wet weather.

E. B. WINGATE,
City Engineer.

City Engineer's Office, Hamilton, August, 1900.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 56.

TAR-MACADAM ROADWAYS.

A report on the subject, written by Mr. Heddle, Assistant City Engineer, is printed in this report, which fully explains the subject. This class of pavement is not suitable to be used on streets having street-car tracks, but does well on residential streets and on streets of moderate traffic. The

price in the past, as on Hughson Street, between King and King William Streets, which has now been down four years and is still in good order, was 68 cents a yard. Trinidad Asphalt cost $2.10 to $2.60 a yard. We have studied the Tar-Macadam pavements somewhat, and I still believe the plan of grading the stone in layers is better than that of mixing them in a heterogeneous mass, as I understand is done by some cities.

It is stipulated that the foregoing typewritten copy is a correct copy of Plaintiff's Exhibit 56, offered and received in evidence in the case of Warren Brothers Company vs. Oskar Huber, and referred to in the transcript of appeal and said typewritten copy may be used with as full force and effect as the photographic copy thereof stipulated to be substituted for the original.

RICHARD W. MONTAGUE,
Of Attorneys for Appellee.
L. A. LILJEQVIST,
Attorney for Appellant.

[Endorsed]: No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Dec. 31, 1923. F. D. Monckton, Clerk.

Plaintiff's Exhibit No. 58.

[Endorsed]: U. S. District Court, District of Oregon. Filed June 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

TABULATION OF ANALYSES

of

Eight (8) Samples of Bitulithic Mixture from ASHLAND–GREEN SPRINGS MOUNTAIN ROAD SECTION OF PACIFIC HIGHWAY, JACKSON COUNTY, OREGON, Laid by Oskar Huber in 1920—Up to and Including May 4, 1920.

WARREN BROTHERS COMPANY, PORTLAND LABORATORY.

Form 89-113-2,000

State Oregon

City Jackson Co.

Street Pacific Highway 1920

Date										
Lab. No.										
B. C.— D										
L										
21 flux										
24										
55										
B										
Surface Bit. Plant Hydr.										
Lab. "										
" *Dow										
" *Cg										
P. C. Bit. Pen. Hydr.										
" *Dow										
" *Cg										
Bin 6										
5										
4										
3										
2										
1										
Dust										
B. C.—										
Bitumen %	6.5	6.7	6.8	6.6	6.7	6.5	7.0	6.5	6.6	
Pass 1½" %	5.7	8.2		9.1		9.2			2.1	
Pass ¾" %	14.6		14.1	8.2	13.1	7.0	5.6	14.1	9.7	
1" %	7.3	12.8	16.1	15.9	12.8	12.4	11.0	13.4	13.1	
½" %	16.5	14.9	10.1	21.3	11.0	14.9	16.6	15.6	14.2	
¼" %	10.2	23.9	19.8	12.8	10.0	19.6	15.9	16.1	15.7	56.8
⅛" %	5.0	9.4	8.7	9.2	14.0	9.0	8.6	9.0	9.1	
8 %	3.0	2.7	5.6	5.2	6.1	5.6	6.6	2.7	5.2	
10 %	12.4	11.5	11.5	9.1	9.9	8.6	8.4	6.9	9.8	
20 %	6.7	4.3	4.6	4.5	5.1	4.2	4.7	4.5	5.7	
30 %	3.6	3.4	3.2	2.6	3.1	3.2	3.5	3.6	3.1	
40 %	2.7	2.0	2.4	2.2	2.1	2.4	2.2	2.2	2.3	
50 %	2.1	2.4	2.1	2.2	2.4	2.2	2.2	2.1	2.4	
80 %	1.6	1.3	1.4	1.3	1.2	1.3	1.3	1.3	1.8	
100 %	1.5	2.2	2.6	2.3	2.3	2.	2.3	2.3	2.6	1.84
200 %	2.0	2.2	2.1	2.2	2.2	2.1	2.2	2.3	2.6	2.6
Hrs. Mixed										
Batches "										
Car tracks										
% grade										

Plaintiff's Exhibit No. 59.

[Endorsed]: U. S. District Court, District of Oregon. Filed June 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

TABULATION OF ANALYSES.

of

Sixteen (16) Daily Samples of Bitulithic Mixture from SALEM–DALLAS ROAD, POLK COUNTY, OREGON, Laid by Oskar Huber in 1919.

WARREN BROTHERS COMPANY, PORTLAND LABORATORY.

Form 209 6-5-18 1m

Polk Co., Ore. — Oskar Huber, Contractor
Salem—Dallas Road

State Oregon

City Plant at Eola, Ore.

Street 1919

Date	10-5-19	10/6	10/7	10/8	10/13	10/14	10/15	10/16	10/17	10/18	10/20	10/21	10/23	10/24	10/27	10/29	Average	
Lab. No.	26011	02076	02097	02196	02229	02270	02308	02332	[illegible]	02407	[illegible]	[illegible]	[illegible]	02612	[illegible]	02648		
B. C. — D																		
L																		
21 flux																		
24																		
55																		
B																		
Surface Bit. Plant Hydr.																		
Lab. "																		
" °Dow																		
" °Cg																		
F. C. Bit. Pen. Hydr.																		
" °Dow																		
" °Cg																		
Bin 6																		
5																		
4																		
3																		
2																		
1																		
Dust																		
B. C. —																		
Bitumen %	6.8	6.9	6.6	6.9	6.5	6.5	6.1	6.6	6.1	6.6	6.0	6.9	6.1	6.2	6.4	6.6	6.5	
Pass. 1½" %									2.5	4.1	6.0						.9	
Pass. 1¼" %	9.3	11.0	3.6	10.8	14.0	6.5	7.0	9.7	16.2	9.0	14.6	14.3	11.0	8.0	15.0	10.3	10.5	✓
1" %	21.3	21.4	19.8	19.8	8.5	18.2	23.1	21.0	12.9	11.9	16.0	19.5	16.9	18.0	9.0	20.1	16.4	[illegible]
¾" %	16.6	15.4	13.0	17.4	11.3	16.1	17.5	13.3	14.9	11.3	15.0	12.8	14.0	16.0	16.5	17.1	14.9	
½" %	15.7	16.0	13.2	14.2	18.6	15.3	14.4	19.8	18.6	14.4	14.2	14.6	14.1	20.9	16.2	18.1	15.6	
¼" %	6.3	9.3	4.0	4.2	6.2	7.3	5.6	4.0	6.5	7.5	5.5	4.5	4.1	5.2	6.3	5.5	6.3	
8 %	1.8	3.3	2.6	0.9	2.0	2.0	1.8	2.3	2.9	3.5	2.5	1.4	1.5	2.2	2.6	2.0	2.1	
10 %	2.6	4.3	2.5	2.3	4.3	3.3	2.1	2.7	3.9	4.2	3.7	3.6	3.0	4.1	4.6	2.7	3.3	
20 %	2.9	4.0	2.7	5.4	4.5	4.8	2.2	3.0	3.5	3.3	3.4	3.7	3.0	4.2	3.2	2.6	3.5	46.1
30 %	3.9	4.9	3.3	4.7	6.0	5.0	4.4	4.5	4.7	4.1	4.1	4.0	2.9	4.6	5.0	3.8	4.4	
40 %	2.4	2.4	3.6	4.4	3.4	3.2	2.6	4.4	2.9	4.1	4.0	2.8	2.1	4.9	2.6	3.3	3.6	
50 %	5.6	9.6	17.6	9.8	8.2	9.3	8.3	8.1	9.1	9.9	6.4	8.2	9.3	7.5	10.6	8.4	8.9	
80 %	3.5	3.2	5.0	1.8	3.2	4.3	5.5	4.7	2.6	3.9	2.8	2.4	3.6	2.6	2.9	1.8	2.9	
100 %	3.5	4.3	5.6	4.9	3.9	3.9	3.6	3.1	3.6	3.9	3.5	4.1	4.4	6.1	4.1	2.6	3.9	
200 %	3.4	3.6	5.0	2.5	3.6	3.8	3.3	7.0	3.4	3.3	3.6	3.8	4.6	3.9	3.6	3.4	3.4	3.4
Hrs. Mixed	8	8	8	8	7½	8	8		8	8	6	1	4	8	8	1½		
Batches " Total	26	108	36	102	[illegible]	44	47	81	47	88	44	37	61	45	76	26		
~~Car Tracks~~ Rate		[illegible]	64		53	56	68	45	66	68	76	41			58			
% grade																		

Defendant's Exhibit "C."

[Endorsed]: U. S. District Court, District of Oregon. Filed June 8, 1922. G. H. Marsh, Clerk. No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

In the District Court of the United States for the Southern District of California, Southern Division.

No. F.–1—EQUITY.

WARREN BROTHERS COMPANY,

Plaintiff,

vs.

C. M. THOMPSON, O. M. THOMPSON, E. O. THOMPSON, Copartners Doing Business Under the Firm Name and Style of THOMPSON BROTHERS, H. E. VOGEL and J. B. HILL,

Defendants.

AFFIDAVIT OF EDWIN C. WALLACE.

United States District Court, for the Southern District of California, Southern Division.

IN EQUITY—No. F–1.

WARREN BROTHERS COMPANY, a Corporation,

Plaintiff,

vs.

C. M. THOMPSON, O. M. THOMPSON, E. C. THOMPSON, Copartners Doing Business Under the Firm Name and Style of THOMPSON BROS., H. E. VOGEL and J. B. HILL,

Defendants.

Affiant, Edwin C. Wallace, being duly sworn, declares and says:

That for more than twenty-five years he has followed the profession of Chemist, that he is a member of the American Chemical Society; The American Society for Testing Materials and the Society of Chemical Industry of London, England; that for many years he has made a specialty of testing bitumens and bituminous pavements, etc., and that the following is a chronological recital of his experience in that line of work.

From 1891 to 1894 while a special student in Chemistry at the University of Cincinnati he devoted his spare time to investigative and experimental work on asphalts and asphalt pavements under the supervision of Mr. Samuel Whinery, then General Manager of the Warren-Scharf Asphalt Paving Company with headquarters at Cincinnati.

In 1894 he regularly entered the employ of Warren-Scharf Asphalt Paving Company, assuming charge of the laboratory which had been built up during the previous years of experimental work. In 1897 he assumed charge of the laboratory of the Warren Chemical & Manufacturing Company established at their plant in Long Island City, N. Y., where they were engaged in the refining of asphalts, distillation of coal tar and the manufacture of roofing felts, mastic and other bituminous products; this company being a subsidiary of the Warren-Scharf Asphalt Paving Company; the Cincinnati Laboratory of the latter company was abandoned.

In 1900 he became first assistant in the New York Testing Laboratory, then under the direction of Clifford Richardson, said New York Testing Laboratory being the technical department of the Asphalt Company of America (now General Asphalt Company) and having technical supervision of all pavements laid by that organization and their several subsidiary companies. During the two years he was connected with this laboratory he visited many cities in the discharge of his duties and had complete charge of all the work during several months in 1900 and 1901 when Richardson was absent from the United States.

In March, 1902, he entered the employ of Warren Bros. Company of Boston as technical expert on bituminous mixtures and in the discharge of his duties visited all the plants engaged in laying the Bitulithic pavement throughout the United States of America and Canada with the exception of New England and the territory contiguous thereto over which the supervision was exercised directly by the Boston Office.

In 1907 he assumed technical direction of all work done by that Company and general control of the Laboratory, which connection lasted until 1909. In the spring of 1909, owing to ill health, he severed his connection with Warren Brothers and soon thereafter filed the application which eventuated in the patent in suit.

Affiant states that while the application for this patent was pending he made a thorough examination of United States patents pertaining to pavements,

making notes thereon and familiarizing himself with the novel features of all the important patents and he states that he has examined the list of patents offered by the defendants in this case as anticipations of the patent in suit, and states he has records of and is familiar with all but five of the patents cited, and of these five two were issued from six to eight months after the effective date of the patent in suit, and that the other three have been examined and found to have no reference or connection whatsoever with bituminous pavements or their construction; one of them referring to the construction of floors suitable for skating rinks made of Portland cement concrete, another referring to the construction of roofs composed of bituminous materials combined with coke or cork or other lightweight body materials, while the third was for a method of heating the mineral aggregate for use in bituminous concrete, which method is substantially identical with that used by Warren Brothers Company since the very inception of their business. Affiant states that no single patent cited by defendants nor any collection of them either anticipates or discloses the invention covered by the patent in suit, that of the numerous patents cited in this record many of them have not the slightest resemblance to the present construction, and that they must have been cited merely for the purpose of making a formidable appearing list of references and the most cursory examination would have shown them to be irrelevant, and that the few which might be construed as having some bearing on

the present case were cited by the Primary examiner during the prosecution of this case in the patent office, which application was finally allowed and the patent finally issued for a new and useful invention for the construction of a street pavement.

Composition or bituminous pavements derive their name from the bituminous composition used for cementing together the particles of mineral matter which forms the body of the pavement. There is no bond of union between the pieces or particles of the mineral matter other than that formed by the bituminous cement; which constitutes less than 1/8 of the mass of the pavement. A pavement of this kind may be said to consist of two distinct elements, possessing entirely different physical properties, one being the mineral or weight bearing element and the other the adhesive cementing or bonding element. From the earliest days it has been recognized that the chief problem by which the industry was confronted was how to use sufficient bituminous composition to effectively bind the mineral particles together, render the mass impervious to moisture, and still have sufficient stability to prevent the deformation or distortion of the surface caused by traffic, generally referred to as ridging, rolling, shifting or shoving. To obtain this desirable result various devices have been tried, chemicals have been used and combinations of all sorts have been made.

The term pavement is a broad one. Originally applied to floors beaten down so as to become hard, it has come into general use for any kind of a sub-

stantially rigid level surface which can be used for foot or vehicular traffic. Pavements have been constructed of plates of iron, blocks of wood, brick and stone, while composition pavements have been constructed in both block and sheet form.

The term is still further complicated by the fact that it is sometimes used to designate the entire structure including the foundation and supporting layers while at other times it refers merely to the wearing surface. This applies particularly to composition pavements as in this construction the supporting layers bear an important part. The fact has long been recognized that compositions satisfactory as foundations or supporting layers were not always satisfactory as wearing surfaces, for the chief requirement of foundation layer was capacity to withstand heavy compression and shearing strains (rigidity) while the wearing section in addition to compression, etc. is also subjected to attrition and impact, as well as being exposed to the action of the elements. It is conceivable that a rigid body might successfully withstand great compression and shearing strains but unless it was also tough and tenacious it might fail under impact and attrition.

Each fragment, piece, grain or particle of mineral matter, regardless of its size, any detached portion, may be considered as a unit. The smallest particle of dust is a unit just as much as the largest piece or fragment of stone or grain of sand or gravel. A mass of impalpable powder is merely a collection of extremely small units. However small these individual units may be they are each and every

one an aggregation of an immense number of molecules united by the force of cohesion. If a large number of very small units of mineral matter were cemented together by some adhesive material equal in strength to the force of cohesion which binds the molecules together the result would be a body equal in strength to a solid body of the same mineral matter, but where the adhesive cement is not equal in strength to the force of cohesion the result would be a body having less strength than a solid body of the mineral matter, and the greater the difference in strength between the adhesive cement and the cohesive force the greater would be the difference in the strength of the bodies. Similar results would obtain if the strength of the adhesive cement varied under different conditions. With bituminous cement that is precisely the condition which exists. The adhesive or bonding strength of bituminous cements varies greatly with the temperature. As an illustration of how the strength of bituminous cement varies with the temperature the following results may be cited. Two brass discs having slightly concaved surfaces and an area of two square inches were cemented together with ordinary paving cement made with Trinidad asphalt; at 50° F. these discs, in tension would sustain a load from 600 to 650 pounds before breaking apart. At 80° F. this load was reduced to between 75 to 90 pounds and at 90° F. no test could be made with the apparatus used as the discs pulled apart as soon as the load was applied.

When the cement was made harder to sustain loads at the higher temperature it was found that it was affected more by impact and attrition.

It can be shown that these cements are affected most by attrition and impact at the temperatures at which they sustain the greatest load under tension.

Equal volumes of mineral matter composed of large or small particles may contain the same amount or mass of mineral matter, but the surface area of the particles which has to be covered with cement in order to bond the particles together is much greater with the fine than with the coarse material.

In order to coat all the surface of all the particles it would therefore require more adhesive cement with fine than with coarse mineral matter.

In a pavement the foundation or suppotirng layers are protected from impact and the chief requirement is the power to resist displacement under heavy loads. It has long been recognized in the paving art that a mass of large stones not bonded together possesses a greater degree of rigidity than a mass of smaller stones because of the greater inertia of the large mineral units, and where rigidity is the chief requirement, it is quite natural that large stone should be used. In the foundations of all structures where conditions will permit, it is the custom to use large units of stone, and it is best to use the largest units of stone that the dimensions of the construction will permit.

In road building it has long been the custom to place the largest stones in the lowest layers. When composition pavements first came into general use, the cost of hydraulic cement was such that it was not so generally adopted for foundations as in present day construction and recourse was had to a multiplicity of layers of stone or composition superimposed one on the other.

Where layers of composition were used as supporting layers they were generally composed of an indiscriminate mixture of coarse and fine mineral units. Several layers were frequently used and it was the general custom to use the coarse material in the lower layers, each successive layer being composed of finer material. Many patents were issued for methods and products, long since abandoned, which in the light of present day practice appear absurd, but through them all it is evident that certain qualities or properties have been considered essential. When concrete came into general use and the use of bitumen derived from coal tar as cementing agent was supplanted by asphalt, natural or derived from petroleum, the construction now known as "asphalt pavement," was gradually developed. Many defects developed in the earlier constructions and the causes to which they were ascribed and the reasons given therefor were as various as the methods adopted for their correction.

It was generally conceded that a successful pavement should have sufficient resistance to compression and shearing strain to withstand heavy loads, that it should also have a certain degree of plastic-

ity in order to withstand the impact and attrition of traffic, that it should be substantially impervious to moisture and that its susceptibilty to changes of temperature should be reduced to a minimum.

Of the many patents taken out a few may be regarded as typical of the methods of construction. The patents to Scharf, Bailey, Parisen, Averill, DeSmedt and Barber refer to foundation and intermediate layers as well as wearing surface, while patents to Richardson, Warren, Whinery and Malette refer more specifically to wearing surfaces.

Other patents have been issued along these lines, differing in details, but this list is fairly representative and the patents cited are the most important.

In all cases the wearing layer is the only layer exposed to the action of traffic, the other layers being merely supports for the wearing surface. These supports in some cases were built as a single layer, in others as a plurality of layers superimposed. It is noticeable that with all the different kinds of foundation and variation in number and thickness of the supporting layers, the wearing surface has always been regarded as a thing apart, an entity, separate and complete. The thickness of the supporting layers varies from one inch to one foot but the thickness of the wearing surface has practically been confined to within the narrow limits of 1½ to 3 inches.

Many different bituminous compositions have been used in both supporting and wearing layers and mineral aggregates of many kinds and sizes have been used, but the wearing layer has always differed

in some respect from the underlying layers. When composed of similar materials something has always been added to or omitted from the composition of the wearing layer and apparently it was always considered necessary that it should be of substantially uniform composition throughout its thickness. That results have not been altogether satisfactory is evidenced by the number of patents issued to remedy defects and that there was also a wide divergence of opinion as to the best method of accomplishing that result is evidenced by the variety of methods as expressed in the patents.

Averill's patent No. 211,313 provided that the layers should be unattached so as to move freely on each other. Eight years later the DeSmedt patent No. 375,273 was granted, claiming that greater strength was imparted to the wearing layer by interposing a layer of "binder" between the concrete and the wearing layer and causing the two layers, binder and wearing surface, to adhere. This is diametrically opposed to Averill's idea. The Barber patent No. 391,222 considers it still better to cause three layers to adhere and therefore substitutes for DeSmedt's concrete a layer of bitumen coated stone. The wearing layer in all these cases was substantially the same, a fine mineral aggregate, sand, combined with a bituminous cement composed of Trinidad asphalt softened with petroleum residuum. Each of them, Averill, DeSmedt, Barber, all men versed in the art, tried to improve the wearing surface by changes made in the underlying supporting layers. Scharf, Bailey and Parisen also

show the greatest variations in their underlying supporting layers but even in this respect Bailey and Parisen are much alike but Parisen's idea seems to be more in accord with DeSmedt's than Averill's since he tried to insure bonding the layers together by sprinkling each of them, after compression, with the same bitumen used in the construction. Any one of the layers of Scharf, Bailey, and Parisen could have been substituted for any one of the layers described by the others and practically the same results obtained, since each layer was complete in itself and substitution of one layer for another would not have affected contiguous layers in the slightest degree.

In 1898 Clifford Richardson obtained a patent, No. 697,884, in which an attempt was made to regulate the proportion of various sized units of the mineral aggregate and by this regulation control, within certain limits, the amount of bituminous cement required to coat the particles.

Richardson directed his development entirely to the wearing surface, assuming that the problem so far as underlying layers were concerned was solved.

Richardson was an advocate of fine mineral aggregates and in this patent the largest units passed a screen of 10 meshes per linear inch.

Richardson laid his wearing surface two inches thick and uniform throughout its depth.

In the construction of wearing surfaces use has been made of coarse aggregates and fine aggregates, but whatever the nature of the aggregate

or the kind of bituminous cement used special efforts appear to have been made to have them uniform throughout the layer and wherever the thickness has been specified it falls within the limits of 1½″ to 3″.

Warren, Whinery and Malette, the more recent advocates of the use of coarse rather than fine mineral aggregates also produce wearing surfaces substantially uniform throughout, Malette does spread some fine mixture over the top of his wearing surface composed of coarse aggregate after it has been thoroughly compressed but states specifically that it is NOT AN ESSENTIAL feature of his invention but is merely resorted to to give a finish (temporarily), and in an alternative which he desribed he omits the fine mixture entirely and uses a finishing layer of limestone screenings or fine gravel without any coating of pitch or bitumen.

In practice, whenever coarse aggregate has been used it has been found necessary to paint the top of the wearing layer with more or less liquid bitumen in order to seal the top of the surface and render it impervious to moisture.

Prior to 1901 coarse aggregates for bituminous wearing surfaces had seldom, if ever, been used successfully.

In 1901 patents were issued to Warren, Whinery and Malette for construction of bituminous wearing surfaces in which coarse mineral aggregate was used.

The only thing in common in the patents issued

to these three different persons was the use of coarse aggregate for the wearing surface.

Both Mr. Warren and Mr. Whinery had had years of experience in the construction of "asphalt pavements," each had recognized that there was something lacking in that method of construction and each had turned to the use of coarse stone in the wearing surface to correct what they considered defective construction. In the course of the next few years other patents along similar lines were issued to Warren, and one in particular, No. 727,505, has been finally adjudged to be a valid patent after protracted litigation as to its novelty and utility.

Prior to the Warren patent, broken stone or gravel had been used mixed with fine mineral matter or sand for the construction of bituminous wearing surfaces, but no attempt had been made to grade and re-combine the different sized particles in predetermined proportions. Warren adopted the method of determining the sizes of the particles within certain limits and then combining the coarse with the fine in proportions best adapted to secure a certain result which he termed "inherent stability." He had determined by experiment that by mixing the coarse and fine aggregates of the material to be used in proportions varying according to the sizes of the respective materials, mixtures could be made in which the voids were greatly reduced and stability greatly increased. His idea was to use the largest possible amount of coarse material with fine material merely suffi-

cient to reduce the voids to a minimum, this aggregate then to be combined with bituminous cement and laid and compressed in the usual manner.

In practice, however, it was soon found that the maximum of coarse material as indicated by the void test did not give the best result, owing to the tendency of the coarse particles to crush under traffic and a decided modification had to be made; the resulting mixture, however, still came within the scope of the Warren patent as the voids were unquestionably low and the mixture stable.

The stress and strain to which a composition pavement is subjected is not uniform throughout the thickness of the layer, but varies both in kind and intensity at different depths of the layer.

These might be roughly defined as general strain to which a section would be subjected throughout its depth, as compression, and special strain such as impact which acts directly upon the superficial area of the layer.

Examinations of samples of bituminous pavements which have been subjected to traffic show conclusively that in the superficial area of the wearing surface, subjected directly to the impact of traffic the mineral matter is crushed and reduced to a finer state of subdivision than the mineral matter in the lower portion of the layer, although at the time of laying the same material had been used throughout. The coarser the grains of the mineral matter used the greater the relative reduction in size and con-

sequent increase in the number of detached grains or particles of mineral matter.

The only bond of union between the units of mineral matter is that afforded by the bituminous cementing medium and the amount of that medium which can be used is controlled by the size of the units, the larger the units the smaller the proportion of the cementing medium; this cement merely coats the surface of the mineral units and does not penetrate into the body thereof.

It follows therefore that when the units are broken, surfaces which are not coated by the cementing medium are exposed, at least two uncoated surfaces for each fracture of a grain or particle. These uncoated surfaces are a source of weakness, and the degree of weakness depends entirely on the composition of the layer. If the mineral units are small and the proportion of cementing medium sufficient, under the kneading action of traffic, these surfaces may become re-coated with the cementing medium; but where the mineral units are large the proportion of the cementing medium is less and the greater inertia of the units offers greater resistance to the kneading action of traffic so that the dry surfaces are not so likely to become coated by the cementing medium; these dry surfaces permit the ready absorption of moisture and disastrous results usually follow.

The tendency of loads moving over the surface of a pavement is to push the wearing surface ahead of the load, while the foundation on which the layer is supported tends to maintain the layer in a state

of rest. These counterforces cause a stress and strain to be set up within the mass of the layer and cause the separate units of mineral matter to move, one on the other if not evenly supported on all sides.

Warren recognized this and attempted to correct it by producing a mineral aggregate which was firm in itself, by reducing the voids in the aggregate to the lowest practical degree.

Warren's idea was a step in the right direction, but the volume of voids cannot be controlled solely by regulating the quantity of each of the various sizes of units which compose the aggregate. The juxtaposition of the units is also an important factor. No control could be exercised under the Warren patent.

The key note is the relative position of the units, and that cannot be controlled by making a promiscuous mixture of large and small units from top to bottom of the wearing surface, even though the number of units of various sizes be limited.

Warren was chiefly concerned with the composition of his wearing surface, practically all his efforts being centered on the sizing and proportioning of the particles, or units, of the mineral aggregate employed, and this was the same throughout the layer, or as Warren says in patent No. 727505 "the grades being thoroughly mixed and thereby being properly distributed throughout the mass."

In the patent in suit the chief concern does not lie with the composition of the wearing surface nor with the composition of the mixtures used in the

formative process, but lies chiefly with the structure of the completed wearing surface as produced, irrespective of the actual composition of the material used.

The novelty and utility of this method of construction is beyond question and wherever it has been tried in comparison with other forms of construction has always proven its worth, frequently to the exclusion of older and more widely known methods of construction.

One of the unusual and novel features of this method of construction, necessary to produce the desired result and one which at the outset was considered highly objectionable is the necessity of handling the two kinds of mixture (coarse and fine) substantially concurrently.

It is well known that in the practice of constructing a pavement built up of layers of mixtures of different composition, it is the custom to lay one layer at a time, frequently for several days, then to change to another mixture for the next layer. In the method, covered by the patent in suit, however, it is necessary to follow up the coarse mixture with the fine before the former has become cold in order to secure the proper compression on the coarse mixture and also assure the desired blending and bonding of the two mixtures into a single non-cleavable layer. If this blending and bonding is not secured and the fine mixture does not become an integral part of the coarse layer, it scales off or wears away or becomes distorted within a few weeks or months according to traffic conditions.

Where the two mixtures have been properly blended and bonded together and the fine mixture becomes an integral part of the pavement, it has lasted for years under traffic conditions which have fully demonstrated its improvement over other methods of construction.

By the preferred method of construction pointed out by the patent in suit the large mineral units of the lower layer are neither in close contact nor in fixed position relative to each other when the fine mixture is spread over the top, but are disposed loosely on the foundation. The pressure which brings the large units into close contact and bonds them together acts first on the fine mixture and tends to force it into the interstices of the upper portion of the layer of coarse mixture and at the same time it consolidates said layer by causing a change in the relative position of the particles of which it is composed.

The two mixtures are thus caused to blend and become bonded together without joint, or cleavage-like plane of union, and cannot be separated into their original parts. Since the force which causes the fine mixture to blend with the coarse is the identical force which brings the units of the lower layer into closer relation and into fixed position relative to each other, the interaction is such that stable equilibrium is established. The large mineral units at the top of the layer of coarse mixture are thus firmly wedged into position and effectively supported on every side, instead of being merely seated

on underlying particles without proper lateral support.

This lateral support acts as a preventive of the rolling or rocking of the large units upon each other, or upon the matrix of fine mixture, and it may be likened to the construction of an ordinary arch of masonry, where by means of wedge shaped blocks and a keystone vertical stress is so resolved into transverse stress that the load is supported by piers at the side but not directly under the load. By having the large units supported laterally, a stress which would tend to move a unit in a vertical direction would have less effect on that unit than it would if such support were lacking. If the resistance at all points were equal to the stress, it is obvious that the unit would remain at rest, but if, in any direction, the resistance does not equal the stress obviously the unit would move in the line of least resistance and a rocking or rolling motion would be imparted to units which are not supported laterally as well as vertically.

Warren, Whinery and Malette, the three latest advocates of the use of coarse mineral aggregates for wearing surfaces of composition pavements, were in accord in the idea that with such aggregates "the stone takes the wear."

When reduced to practice it was soon found that this was true, literally true; the stone took the wear to an extent which was surprising and the pavements were often much the worse for it within a very short period of time. Malette realized this and within four months from the date of his first

patent had obtained a second one in an effort to correct the defects of the first. Warren also found it necessary to modify his construction by increasing the proportion of fine material above that indicated by the void test as giving the lowest percentage of voids. The difference between the lowest possible and the lowest practicable percentage of voids was one which often called for great nicety of decision.

In the patent in suit "the stone bears the load," as it is well suited to do, but it is protected from "wear" by a relatively thin coat of impact-resisting mixture, which is in turn protected from deformation or displacement by the "load-bearing stone." By discarding uniformity of composition throughout the entire mass for adaptability to resistance to stress, a wearing surface is produced which is stable where stability is most needed, but plastic where plasticity is more desirable.

This impact-resisting coat serves the double purpose of protecting the stone from abrasion, and also renders the surface substantially impervious to moisture. The product produced by this method of construction is complete within itself with maximum resistance to the effect of traffic and to the action of the elements as well.

Warren found by experience he had to provide some means of rendering the superficial area of the wearing surface produced by his process less pervious to moisture; he therefore painted the surface with a liquid bituminous composition afterwards spreading stone chips over the paint. The

necessity of applying the liquid paint composition shows that the Warren product, which theoretically was correct in principle, was not practically "complete in itself" but required an additional step in the process of construction.

This paint method of sealing the surface was a return to the practice of earlier days, and was soon found to be a source of annoyance and often of considerable expense, as no practical method was ever found by which it could be kept under reasonable control.

In practice under the Warren patent the effort was made to provide a malleable fine bituminous surfacing by using a surplus of the fine ingredients and bitumen with the coarse aggregate comprising the wearing section and depending upon compression to bring this surplus fine aggregate and bitumen to the surface. This was partly accomplished but at the expense of detracting from the stability of the entire structure because it left a surplus of the bituminous mortar element throughout the structure. Under the patent in suit the extremely desirable malleable surface is accomplished and at the same time the stability of the structure retained.

Construction under the patent in suit does not produce a multi-layer pavement, but a combination of two dissimilar mixtures into a single layer with a merging of coarse into fine or fine into coarse, viewed from the bottom up or the top down. A sectional view could not be represented by two parallelograms with one side common to both, as neither the base line of the fine aggregate topping

mixture nor the top line of the coarse aggregate body mixture, could be represented by a straight line, but rather by one which is irregular, sinuous and deeply indented. A structure is thus produced composed of elements, each of which is best adapted to the purpose for which it is intended. The load-bearing element containing large mineral units, which impart stability, is used only where stability is the essential feature, while the impact-resisting element is composed of small mineral units as being best adapted to resist abrasion by its pliability. By blending these two elements together the change from stability to pliability is more gradual than could otherwise be obtained. It is doubtful if any two sections could be made through this structure, in any direction, which would show the same composition or the same relative proportions of the two mixtures.

In a multi-layer pavement there is a plurality of layers of composition; each layer, while it may differ from contiguous layers, is substantially uniform throughout. A section through any one of the layers, through any part thereof, or in any direction would show it to be substantially uniform as to both composition and thickness. Each of the layers being of uniform composition would possess the same characteristics or properties throughout, and the superimposed layers might be likened to a number of boards glued together. The boards might vary in thickness and be made from various woods but there would be no blending parts such as oc-

curs when two pieces of metal are welded together.

The difference between composition and structure may be shown by the well known type of road known as macadam, which is a structure and not a composition, as it is not uniform throughout the thickness of the wearing layer.

In this construction a layer of stone is placed upon a previously prepared base and fine material forced in from the top by the kneading action of a roller, so as to secure lateral support for the stone forming the body of the roadway. In this way a firm and substantial structure is produced without recourse to adhesive cements. The same results could not be obtained by mixing coarse and fine aggregate indiscriminately and then placing a layer of identical thickness upon the same base and compressing it with the same roller. No matter how carefully the proportions of coarse and fine material were determined the results would not be the same.

The excellent results obtained with the ordinary macadam roadway has caused many paving experts to attempt to reproduce it with the addition of an adhesive cementing medium like bituminous cement. Unfortunately this has generally been done without taking into consideration the change wrought by the addition of such adhesive material.

In plain or so-called waterbound macadam it is necessary to compress the layer of stone forming the body of the roadway before applying the fine material, as otherwise the fine material works

through the mass to the bottom of the layer of coarse stone, with unsatisfactory results.

Furthermore, the water applied during the later compression, is a mobile liquid which readily permeates the mass, carrying with it the finer particles of dust into the smallest of the interstices and since the stone wears more by attrition when watersoaked some of the extremely fine dust is doubtless formed "in situ" and acts to wedge the stone in place.

All this is changed, however, when bituminous cement is used, since its viscous adhesive nature prevents the very action on which the success of the process so largely depends. Efforts to use bituminous material in this way have usually resulted in the production of multi-layer pavements with most of the layers lacking in stability. Except under extremely light traffic conditions, results have never been satisfactory.

In the patent in suit this difficulty has been overcome by producing a wearing surface consisting of a single layer, one and inseparable, a structure with the different sizes of the mineral aggregate placed where they are most needed rather than a mere compound.

To adapt various parts of the structure to resist the particular stresses to which they would be subjected seemed to be more logical than to make predominant any one quality at the expense of others equally necessary.

This can be accomplished by following the process covered by the patent in suit.

The large mineral units of the body of the layer

impart stability thereto while fine mineral units, which are less injuriously affected by impact, are used to advantage in that portion subjected to the direct action of traffic.

It is the blending, the welding, the amalgamation into a compact integral mass, which permits the use of a plastic fine mixture made so rich in bituminous content as to best accomplish the result, and also permits the reduction of the thickness of that portion of the layer so that stress and strain are minimized by the gradually increasing stability of the mass from the top downward, thus accomplishing an important result which could not be accomplished with any previous construction.

Affiant states that he has carefully compared the specifications entitled "Asphalt Concrete A" under which the pavement constructed by defendants was laid with the specifications and claims of the patent in suit and also what purported to be a sample of the pavement actually laid by defendant and in his opinion the specifications require the construction of a pavement which will infringe the claims of the patent, and the examination made of the samples submitted to him prove that the process pointed out by the patent to produce that product must have been substantially complied with.

(Signed) EDWIN C. WALLACE.

Subscribed and sworn to before me this 26th day of May, 1921.

[Seal] (Signed) ROBERT FOWLER,
Notary Public.

Commission expires March 7, 1924.

ROBERT FOWLER,
Notary Public.

In the District Court of the United States for the Southern District of California, Southern Division.

IN EQUITY—No. F–1.

WARREN BROTHERS COMPANY, a Corporation,

Plaintiff,

vs.

C. M. THOMPSON, O. M. THOMPSON, E. C. THOMPSON, Copartners Doing Business Under the Firm Name and Style of THOMPSON BROS., H. E. VOGEL and J. B. HILL,

Defendants.

CLERK'S CERTIFICATE.

I, Chas. N. Williams, Clerk of the United States District Court for the Southern District of California, do hereby certify the foregoing to be a full, true and correct copy of the affidavit of Edwin C. Wallace filed in my office on June 3, 1921, in the case entitled Warren Brothers Company v. Thompson Brothers, No. F–1 Equity, as the same remains on file and of record in my office.

ATTEST my hand and seal of the United States District Court this —— day of March, A. D., 1922.

[Seal] CHAS. N. WILLIAMS,

Clerk U. S. District Court, Southern District of California.

By R. D. Zimmerman,

Deputy.

United States of America,
State of Colorado,
City and County of Denver.

I, O. W. Jehovah, being duly sworn *and* say: That I am a Photographer and personally took and made the Photograph shown on the opposite side of this paper and said Photograph is a true and correct picture and representation of what appears thereon and shows a portion of the pavement laid in that half of the alley which abuts upon the Undertaking Establishment of E. P. McGovers, 1442 Arapahoe Street; said Photograph was taken on the 27th of March, 1922, in the presence of the persons shown in the picture.

My Business Address is 320 17th Street, City.

O. W. JEHOVAH.

Subscribed in my presence and sworn to before me this 7th day of April, A. D. 1922.

[Seal] JOHN H. MOONEY,
Notary Public.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.

Defendant's Exhibit "E."

United States of America,
State of Colorado,
City and County of Denver.

I, O. W. Jehovah, being duly sworn *and* say: That I am a Photographer and personally took and made the Photograph shown on the opposite side of this paper and said Photograph is a true and correct picture and representation of what appears thereon and shows a portion of the pavement laid in that half of the alley which abuts upon the Undertaking establishment of E. P. McGovern, 1442 Arapahoe Street; said Photograph was taken on the 27th of March, 1922, in the presence of the persons *showing* in the picture.

My Business Address is 320 17th Street, City.

O. W. JEHOVAH.

Subscribed in my presence and sworn to before me this 7th day of April, A. D. 1922.

[Seal] JOHN H. MOONEY,
Notary Public.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.


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United States of America,
State of Colorado,
City and County of Denver.

I, O. W. Jehovah, being duly sworn *and* say: That I am a Photographer and personally took and made the Photograph shown on the opposite side of this paper, and said photograph is a true and correct picture and representation of what appears thereon and shows the full alley in the rear of McGovern's Undertaking Establishment at 1442 Arapahoe Street. The dark spot at the feet of L. A. Liljequist was not a hole but a damp spot in the pavement.

O. W. JEHOVAH.

Subscribed and sworn to, before me, this 7th day of April, 1922.

[Seal] JOHN H. MOONEY,
Notary Public.

[Endorsed]: U. S. District Court, District of Oregon. Filed Jun. 8, 1922. G. H. Marsh, Clerk.

No. 4171. United States Circuit Court of Appeals for the Ninth Circuit. Filed Jan. 2, 1924. F. D. Monckton, Clerk.